AGRICULTURAL ENGINEERING

Established 1920

This journal is owned, edited, and published monthly by the American Society of Agricultural Engineers.

Editorial and advertising departments at the executive office of the Society, Saint Joseph, Michigan. Publication office at Benton Harbor, Michigan.

RAYMOND OLNEY
Editor

RALPH A. PALMER
Associate Editor

SUBSCRIPTION PRICE: To non-members of the A.S.A.E., $3.00 a year in the U. S. and possessions and in Americo-Spanish countries, $3.50 a year in Canada, and $4.00 a year in all other countries; to A.S.A.E. members anywhere, $2.00 a year. Single copies (current), 30 cents each.

POST OFFICE ENTRY: Entered as second-class matter, October 28, 1933, at the post office at Benton Harbor, Michigan, under the Act of August 24, 1912. Additional entry at St. Joseph, Michigan. Acceptance for mailing at the special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized August 11, 1921.

The American Society of Agricultural Engineers is not responsible for statements and opinions advanced in its meetings or printed in its publications; they represent the views of the individuals to whom they are credited and are not binding on the Society as a whole.

TITLE: The title AGRICULTURAL ENGINEERING is registered in the United States Patent Office.

CONTENTS FOR AUGUST 1941

Vol. 22, No. 8

Agricultural Engineering Digest

(Continued from page 270)

TERRACE CONSTRUCTION WITH SMALL EQUIPMENT IN THE SOUTH, *W. A. Weld and P. M. Price.* U. S. Dept. Agr., Soil Conserv. Serv., 1940, pp. 11, figs. 6. It is pointed out that the drainage or channel-type terrace is the most satisfactory for runoff control. The construction of such terraces by means of the plow and scraper, plow and V-drag, one-way disk tiller, and the small-blade terracer or grader is briefly discussed and is illustrated by photographs and diagrammatic drawings.

Literature Received

BALL BEARING HANDBOOK. New Departure, Division of General Motors Corporation, Bristol, Conn., has just issued the 15th edition of its handbook, listing the principal types and sizes of the forged steel ball bearings. This book has a new finger index for quick reference, and in addition to dimensions, capacities, tolerances, and mounting fits, contains new data to simplify the selection of bearings for various loads and length of service. Copies will be furnished on request for designers, draftsmen, and others concerned with the selection and application of ball bearings.

EMPLOYMENT BULLETIN

The American Society of Agricultural Engineers conducts an employment service especially for the benefit of its members. Only Society members in good standing may insert notices under "Positions Wanted," or apply for positions under "Positions Open." Both non-members and members seeking to fill positions, for which ASAE members are qualified, are privileged to insert notices under "Positions Open," and to be referred to members listed under "Positions Wanted." Any notice in this bulletin will be inserted once and will thereafter be discontinued, unless additional insertions are requested. There is no charge for notices published in this bulletin. Requests for insertions should be addressed to ASAE, St. Joseph, Michigan.

POSITIONS OPEN

EXTENSION ENGINEER wanted. The Agricultural Extension Service, University of Nebraska, wishes to fill a position on its staff of agricultural engineering. A man with thorough engineering training and with experience in the fields of irrigation and erosion control, as well as in extension work, will be given preference. Qualified persons, who desire to apply, should send credentials to Agricultural Engineering Department, University of Nebraska, Lincoln, Nebraska.

JUNIOR ENGINEER, ($2000). The U. S. Civil Service Commission announces an unassembled examination for junior engineers, any branch, to meet an increasing need for their services in national defense work. Details are explained in announcement No. 51.

ENGINEERS (various grades, $2,600 to $5,600). The U. S. Civil Service Commission announces an unassembled examination for engineers, in grades from assistant to principal engineer. Agricultural engineers qualified in farm machinery are indicated in a list of those particularly needed in connection with the national defense program. Details are explained in announcement No. 69, issued April 7, 1941.

INSPECTOR, ENGINEERING MATERIALS. The U. S. Civil Service Commission announces an unassembled examination for men for the above classification of work in the Navy Department, in ratings of junior to senior inspector ($1620 to $2600). Details are explained in announcement No. 81.

POSITIONS WANTED

AGRICULTURAL IMPLEMENT BLOCKMAN, with eleven years' sales experience with large manufacturer of farm equipment and three years in agricultural engineering in engineering college, desires position as sales or collection blockman with another similar concern or would consider a position as teacher in farm shop, national defense, or farm machinery research work. Age 37, excellent health, no bad habits. Married. Rural background. Credentials furnished upon request. Am now teaching in state university but will be available September 1, 1941. Can revitalize, give new direction and effectiveness to sales or collection efforts through original methods. Proficient in management, organization, financing. Would prefer Middle West. PW-338

AGRICULTURAL ENGINEER, also farm and supply manager, has had 20 years' experience in agricultural pursuits as manager of large farming enterprise and agricultural supply house, and as chief agricultural engineer of large irrigation development in the West. Has had technical training and practical experience in all phases of engineering and agricultural production, development, and marketing. Best of references. Forty-four years of age. Married. PW-341

AGRICULTURAL ENGINEERING

Established 1920

This journal is owned, edited, and published monthly by the American Society of Agricultural Engineers.

Editorial and advertising departments at the executive office of the Society, Saint Joseph, Michigan. Publication office at Benton Harbor, Michigan.

SUBSCRIPTION PRICE: To non-members of the A.S.A.E., $3.00 a year in the U. S. and possessions and in Americo-Spanish countries, $3.50 a year in Canada, and $4.00 a year in all other countries; to A.S.A.E. members anywhere, $2.00 a year. Single copies (current), 30 cents each.

POST OFFICE ENTRY: Entered as second-class matter, October 28, 1933, at the post office at Benton Harbor, Michigan, under the Act of August 24, 1912. Additional entry at St. Joseph, Michigan. Acceptance for mailing at the special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized August 11, 1921.

CONTENTS FOR AUGUST 1941

Vol. 22, No. 8

EDITORIALS

A Message from the President

To A.S.A.E. Members:

AS YOUR new President, it is my desire that this year's officers, division chairmen, committee chairmen, and committee members do enough serious work in and on this Society "machine" of ours to make it run smooth and fast enough so we will be proud of it, and so we can turn it over to the next operating crew in a little better condition than when we took over. To do that to any machine means work; it means that every part must function.

There has been some criticism of the technical standing of agricultural engineers and of our Society, both from without and within. Before feeling offended and starting a word battle, perhaps we should think, and conduct a little self-examination. If the critics are right, we should smile and *work*; if they are wrong, we should smile and *work* so they may see the error of their own criticism. Criticism of the Society by its members is a healthy condition. It shows they are thinking.

Committees are being set up to look into some criticisms: Industry Committee on Engineering Problems; Industry Committee on Desired College Training; Committee on Curricula of the College Division. The 1941-42 Meetings Committee consisting of A. W. Turner as chairman and the five division chairmen, have met and have plans under way for improved meeting schedules and programs.

"Our profession needs to be better known" many members are saying. There are two schools of thought. One would shout; the other would let our worth-while accomplishments do the shouting for us. Personally, I believe in telling the world of the good things we do in order to help the world, but not in shouting just to make a noise. A society, or a nation, is no better and can maintain no greater prestige than the individuals who comprise it.

In conferences with Past-President Brackett, Secretary Olney, division chairmen, and other members, certain procedures have been decided upon.

Committees. A.S.A.E. representatives on other organizations, and standing and special committees have been appointed, the members notified, and the list published elsewhere in this issue. Many of the division committees will soon be completed. Lists will be published as soon as final. The complete Society organization list will be printed in full in AGRICULTURAL ENGINEERING the first of the year. Preliminary lists are so every member may know what committees there are and who is on them, and so you may make suggestions if you wish. The complete list is for record.

There will be fewer and better committees this year. I am not appointing any division committee until the selected chairman of that committee convinces the division chairman there is a job for that committee to do and that the committee will make an honest attempt to do it. A chairman will have something to say about who shall be members of his committee. He and his committee will be held responsible for producing results.

Committee Activities. Since the Society does not have special funds to carry on committee research, *the committee activity should be closely allied with the regular activity of the individual members.* Chairmen are requested to get in touch with committee members *now* to outline activities, responsibilities, and reports. Reports may be short or long, but they should be specific and should definitely tell agricultural engineers something which will be new and helpful to them.

Committee reports may be made whenever there is something to report and not held until the end of the Society year. A synopsis of the report will be published in the Journal, and mimeographed copies made available to all members who request them. It is hoped reports will come during the year when there is time to read them. If a report has sufficient merit, it may be made the basis of a paper or symposium at the fall or annual meeting.

Chairmen or Monitors. Where certain subjects are of continuing importance in a division, but there are no immediate active developments, a chairman or monitor will be appointed. It will be his duty to keep in touch with his field, and to recommend to his division chairman, the appointment of a committee for a specific job whenever such committee seems desirable. This was the suggestion of G. B. Hanson of the Farm Structures Division.

Committee Records. Each committee chairman is requested to keep an intelligible record of the activities of his committee which will be the property of the Society. (Suggested by H. E. Pinches of the College Division.) This record is to be passed promptly to the succeeding chairman. Inactive material is to be sent to the Secretary's office each year; and at the termination of the committee's work, the complete file will be turned over to the Secretary for filing. Will past-chairmen please send any records they now have to the incoming chairmen or to Secretary Olney?

I ask members not to look upon committee membership or program participation solely as an honor. This Society is yours and mine. If we want the plaudits of other groups, if we want to influence agriculture for good—if we want grain, we must plow and treat and plant and harvest. Committee work and Society work in general is a plow job. Do not think that anyone will class you as egotistical or forward if you offer to plow or make constructive criticisms for improving the job. Sometimes the new and younger men do the best plowing and steering. I think you will agree with me that we cannot "make friends and influence people" just by lending our names to committees and sitting on some hard seats twice a year to listen to a program.

My belief is that two good active committees that produce results are better for us than twenty committees that merely exist on paper. It takes action to win battles these days.

Meetings. The best professional meetings I have attended are the ones where there have been the freest and widest discussions—open discussions from the floor after papers are presented—discussions in the halls and corners. Our programs have been too crowded. This year the Meetings Committee hopes to relieve this condition somewhat by arranging far enough in advance to have more joint division sessions of mutual interest and without duplication, not more than two or three divisions in session at one time, fewer subjects with more participants in each, and possibly only one general session at the annual meeting.

Deadlines on tentative programs will be September 1 for the fall meeting and March 1 for the annual meeting. If a paper is worth preparing or worth hearing, the author or committee should be given at least three months to collect and prepare material. Someday, I hope, we can publish all technical papers in a special May or June issue of the Journal and devote the full time at the meeting to discussing them.

GEO. W. KABLE
President, A.S.A.E.

AGRICULTURAL ENGINEERING

VOL. 22 AUGUST 1941 NO. 8

Agricultural Engineering in National Defense

By S. P. Lyle

FELLOW A.S.A.E.

THE record of the defense of nations in the present world disturbance is not reassuring. It has been tragic! The defense preparations of no country in Europe which has desired peace have been adequate to either discourage or defeat aggression. The world-wide implications of the present conquest of Europe and Asia are not such as to permit our country to take a gambler's chance with inadequate preparation.

A reasonable price for a family to pay for its home is the equivalent of two-years' family income. Many families prefer to pay more. The United States of America is taking a new lease on its home and priceless liberty, a national right and privilege which it wants its good world neighbors also to enjoy. We do not expect our country to expend two years of national income for defense, but we are willing to do promptly whatever is required for a defense adequate to discourage or defeat aggression.

This obviously requires a rate of productive expenditure which will not only exceed that of the aggressors, but a rate which also will rapidly overtake their present lead. To do less appears to involve a hazardous gambling risk.

The American Society of Agricultural Engineers is represented generously in the military personnel now engaged in training for defense. We are greatly honored by these members and will honor their patriotism by contributing generously to the industrial and civil duties of defense.

Agricultural engineering services in the defense of our nation are an integral part of the agricultural effort for defense. President Roosevelt has described the agricultural responsibility as follows:

> "I am taking the position that, broadly conceived, the most vital operating functions of agriculture in the defense program are, first, the guarantee of an adequate supply of food for the needs of this nation and supplemental needs of those nations whose defense is essential to the defense of this country; and, second, the provision of sufficient agricultural raw materials for expanded defense production. In the accomplishment of these major purposes, it will be necessary to assure that the agricultural balance is not destroyed and that the consequent ability of the agricultural population to fulfill its contribution to the defense effort is not impaired."

An address before the annual meeting of the American Society of Agricultural Engineers at Knoxville, Tenn., June 1941. Author: In charge, agricultural and home economics section, division of subject matter, Extension Service, U. S. Department of Agriculture, Past-President, A.S.A.E.

Let us now view the national defense effort as a whole to see our position in perspective.

Defense of the United States in this world crisis is the most stupendous endeavor our country has ever undertaken. In a recent bulletin issued by the Office for Emergency Management, entitled "Defense One Year," the statement is made: "American industry and labor were just beginning to show what they could do in armament production as the first year of defense ended on May 28, 1941." Just a year before that date, on May 28, 1940, President Roosevelt took the first step toward arming this country for any eventuality by appointing the seven-member Advisory Commission to the Council of National Defense. This Council is composed of the Secretaries of War, Navy, Interior, Agriculture, Commerce, and Labor. The Advisory Commission initiated the development of organization for the harnessing of industry to the rearmament program, and made remarkable progress from a standstill start. But meanwhile the defense program was taking more definite form. The Selective Service Act was passed and a goal of a two-million-man army, a two-ocean navy, and a greatly expanded air force had been set. Army cantonments were under construction, American youths were preparing for camp, and clothing, food, and tents, as well as fighting equipment, had to be procured. The job of the Advisory Commission was expanding.

On December 29, the President set an even greater goal for the defense program than the rearmament of the United States stating, "We must be the great arsenal of democracy." A few weeks later the President outlined a plan for "billions of dollars worth of weapons" and soon the lease-lend legislation was taking form.

On January 7, 1941, the President enlarged the administrative organization directing the defense effort by creating the Office of Production Management and coordinating the activities of the National Defense Advisory Commission, the Office of Production Management, and other defense agencies through the Office for Emergency Management. According to its own definition, "the OEM was designed to serve as extra eyes, hands, and brains for the President."

In reporting the year's work the OEM states, "The total

program by mid-May called for expenditures of approximately 40 billion dollars (U. S. and British orders) almost all of it in 1941 and 1942. That is a staggering sum—$300 for every man, woman, and child in the United States. Yet even it will not be enough. The security and freedom of America cannot be measured in billions of dollars."[1]

Since the close of this year of defense, the total earmarked for defense has risen to 42 billion with definite proposals for other billions to step up production of basic materials, and estimates released to newspapers which indicate that the United States will have to spend at least 100 billion dollars to match Germany's war machine. A year ago after building up a reserve from years of preparation Germany was spending a billion dollars a month on armaments. Today we have spent a total of 5 billion and have scarcely attained a rate of one billion a month. Today, Germany is spending nearly three billion a month, or 60 per cent of her national income on war. A 24-hour day 7 days a week is the maximum toward which American industry and labor is striving to overtake the German lead.

According to the Bureau of Research and Statistics of the OPM, during 1941 the United States is scheduled to spend 17 billion dollars, Great Britain about 15 billions, and the rest of the British Empire 5 billions — total, 37 billions for defense and war. The Axis expenditures will total 30 billions. Since the margin is relatively small and not assured nor free from the influence of war effects on Britain, it is clear that the goals will be set higher and production must move faster. Evidence to date seems conclusive that this is a war of equipment and material rather than of man power. Production of an annual 40 billion dollar armament program is no more in proportion to our capacity than Canada or England or Germany are doing now.

STAPLE FOOD AND FEED SUPPLIES ARE ADEQUATE TO THE NEEDS OF THE NATION

These colossal figures and the unprecedented rate of acceleration of production are cited in order that we as engineers serving the agricultural industry may observe, first, the unquestionable priority of defense production needs over civilian production programs, and, secondly, the imminence of the effects of defense production on agricultural production.

The U. S. Department of Agriculture fortunately has been able to reassure the nation as to the adequacy of most of the staple food and feed supplies and cotton. Canada as well as the United States has a large carry over of wheat. However, Secretary Wickard announced two months ago a program of price support on dairy, pork, and poultry products, tomatoes for canning, and dried beans, which met with immediate cooperation by farmers in those areas where production could be increased by more efficient management and operation without expansion of present facilities. The production of more food on farms for farm use has also been greatly increased this year to enable the commercial marketing facilities to meet the increased demand for foods, stimulated and shifted in location by defense military and production operations. Other factors influencing increases in agricultural production are the local demands in the vicinity of cantonments and defense industrial developments, and the recent enactment of parity loan legislation.

On the other hand, consumption of agricultural products is greatly increasing in some lines not only because of the extra requirements of the defense effort of the nation and the increasing purchasing power of its citizens, but also because of a national nutrition program which faces squarely the evidence of malnutrition as an important contributing cause for the 40 per cent rejection of men called for selective service. This program directs the attention of all citizens not only to the inadequate quantity of food available to members of low income families, but also to the inadequacy of nutritive quality in the food which people at all income levels commonly eat. These deficiencies, especially in mineral and vitamin essentials, seldom produce the extreme symptoms of malnutrition except in low income families, but physicians do see very generally signs of subacute vitamin deficiency. The corrective education for this purpose and arrangements for better distribution of foods in a national health program, involve some shifts in production.

PRODUCTION OF MORE FOOD ON FARMS FOR FARM CONSUMPTION AIDS DISTRIBUTION

One very general shift throughout the country is the production of more food on farms for farm consumption. In this very state, this year, over 100,000 Tennessee farm families have undertaken to produce on their own farms 75 per cent of the nutritive requirements for a year's food supply. Those who achieve this goal will be awarded a certificate of merit endorsed by the governor and officials of agencies sponsoring this coordinated phase of the food-for-defense program which is designed to release food for defense needs of the urban population as well as to afford health and non-cash income benefits to farm people. Engineering aid is highly important in this endeavor throughout the nation, as it can facilitate the use of hotbeds, irrigation, storage, processing, refrigeration, freezer lockers, and many other helps to assure abundant supplies of palatable, nutritious home-produced foods.

The agricultural industry, however, in addition to adapting its production program to the food and fiber needs of the national defense program, must also anticipate and meet the shortage of farm labor, mule power, and possibly tractor fuel, and the influence of defense priorities on the availability of machinery, repairs, and other industrial supplies essential to modern agriculture.

To deal with these manifold agricultural problems the Office of Agricultural Defense Relations was established by the Secretary of Agriculture after the President transferred the functions of the Agricultural Division of the National Defense Advisory Commission to the Department of Agriculture. According to the June 3rd issue of Defense, "the Office of Agricultural Defense Relations will develop programs and policies to supply sufficient agricultural commodities to meet the needs of the United States and the democracies and to provide agriculture with sufficient labor, tools, and transportation to carry out its part of the defense effort. In administering its program, the Office of Agricultural Defense Relations will utilize the trained personnel of the Department of Agriculture and will maintain close liaison with all defense agencies."

Obviously agricultural engineering problems will become increasingly numerous and in need of urgent attention as the unparalleled industrial program attains its full momentum. Shortages of farm labor can be met in some cases by changes in the farm products marketed, but frequently more labor-saving machinery will be needed. According to a recent industrial survey, conducted by a private firm, the production rate of farm equipment is increasing. Employment in the farm equipment industry has been increasing rapidly with the employment index for April 1941 at 179, and for April 1940 and 1939 at 141 and 129, respectively. But manufacturers are experiencing some

[1]Defense One Year. Office for Emergency Management, Washington, D. C.

difficulty in securing supplies of iron and steel products, nickel alloys, tungsten, and other raw materials. Rising farm income has been credited with stimulating farm machinery purchases, but earnings of the manufacturers were reported to be below the 1937 level.

Planning by agricultural engineers to meet shortages of labor and machinery is in order, and two practical moves are indicated, namely, to provide mechanical training for farm boys for the operation, care, and repair of tractors and other farm machinery, and to stimulate farmers to keep their equipment currently in good operating condition. Machinery manufacturers learned from experience in the previous world war to prepare inventories of supplies for defense needs and to stock repairs with distributors and dealers. Although the vocational training programs for mechanics and for engineers for defense are giving priority to training for the industrial field, there will doubtless be increasing realization of the need for such services to agriculture to safeguard an abundant national supply of wholesome food, in view of the fact that there are nearly twice as many tractors on farms now as there were ten years ago.

SUCCESS OF FOOD-FOR-DEFENSE PROGRAM DEPENDENT ON LABOR-SAVING EQUIPMENT

Priorities are of special interest to engineers. Some industries serving agriculture are using the slogan "Food will win the war" in order to obtain support for priority claims, and plenty of authorities can be quoted to prove the importance of food in national defense. Priorities, of course, will continue to be given to military needs, but due consideration must be given promptly and continually to the urgency of special agricultural requirements. The following reference is from "Defense", official weekly bulletin of the OEM, for June 3, 1941: "The same strategic metals that go into a plane or a battleship are used to build a tractor or a combine. The farm machinery industry uses iron, steel, copper, chromium, nickel, tin, aluminum, lead, and zinc. In relation to our total production, only a very small amount of these metals goes into farm machinery. With the exception of iron and steel, less than 1 per cent of our total production is normally used for tractors and farm implements. If that 1 per cent were not available, however, the success of the recently launched food-for-defense program might be hampered, Office of Agricultural Defense Relations officials believe."

The importance of that statement becomes more impressive when it is recalled that there are two-thirds as many automobiles on farms as there are farms in the United States, more than one tractor to every four farms, and one motor truck to every six farms. Labor shortage will increase need for such equipment as well as milking machines and electrical labor-saving equipment for refrigeration, water supply, and appliances which require strategic metals in their construction. Some of the stragetic materials are also widely used in farm building construction.

The production and processing of substitute materials may become a special problem, on the one hand, for engineers with manufacturers to produce industrial substitutes for farm use such as sun lamps for cod liver oil, and, on the other hand, for engineers with public agencies to develop the production and processing of agricultural substitutes for imported agricultural products such as castor bean oil for tung oil. Incidentally, the perennial discussion of motor-fuel substitutes from agricultural products does not appear to be revived by consideration of defense priorities for petroleum products, as the shortage of fuel oil and gasoline anticipated in the eastern states would be a result of limitations in transportation facilities. Petroleum production facilities are reported to be adequate for any need, and fortunately are located in or near the areas where the use of tractors is most prevalent.

The widespread drought over the eastern half of the country this spring reminds us forcibly of the value of conservation and soil improvement practices in preparing a reserve resource for defense and in maintaining good yields during a defense period. Planned conservation management usually reduces the labor requirements of a farm and dependence on purchased fertilizers. Irrigation and drainage bring into and maintain production on our most fertile lands, and good engineering design and operation of such projects insure the best yields and quality of products. The agricultural conservation program gives assurance of nationally planned production for defense needs and maintenance of the full value of the soil resources after defense. Engineering cooperation continues to be a prominent integral part of agricultural and soil conservation, and in addition particularly in the soil conservation camp operations, thousands of youths have received invaluable defense training in the operation and maintenance of power machinery.

Housing construction is of especial interest to agricultural engineers as rural housing is already involved in the defense housing program. The Office of Agricultural Defense Relations has not only assisted in the selection of agricultural lands needed for both military and industrial defense operations, but has also, through state and county land use planning committees, arranged for the location of a suitable proportion of the new housing on farms in order that houses occupied during the defense period by industrial workers should remain for use by farm families after defense, at which time the vacated old farm houses will be demolished.

NATIONAL DEFENSE HOUSING PROGRAM INCLUDES RURAL HOUSING AS AN IMPORTANT ITEM

Housing also presents a very desirable type of investment for farm income during a period of rising national expenditures. Competition for farm land increases the capital investment and taxes, but not the income value which in the long run determines the market value. Investment in a better home and buildings suitable to the farm enterprise makes the farm more ideal and indispensable to the farm family as well as more valuable in the community and on the market. The soil of a farm with a good home and adequate buildings can be and will be better conserved than the same land poorly equipped with buildings.

According to statistical records of both urban and rural housing, we are now close to a normal or average rate of investment in housing improvements. The curve is now about at the normal level with a trend evident for increasing expenditures for building improvements. The cycle is apparently comparable to similar cycles in both urban and rural housing expenditures during the first world war. In that case the expenditures for all farm building improvements are estimated to have reached a peak of nearly a billion dollars in 1919, and after a recession in 1921 leveled off on approximately a 600 million dollar average for several years prior to 1930.

There is no assurance of repetition in this present cycle due to the prodigious effort which must be exerted on defense, and which will absorb a larger portion of laborers than in the previous cycle, but the beginning is evident and the trend has significance. Some of the enhanced farm income, for example, will be spent on rural electrification for lines, wiring, appliances, and electrical farm equipment. A strong incentive will exist for expenditures for labor-saving devices, modern conveniences, and luxuries

which because of demand and scarcity might sell at high prices. Since labor limitations will restrict lines of production in competition with defense objectives, tax procedures might be devised to defer lavish spending and restrain price levels.

Since the defense activity can not gain its full momentum for several months, a continuing rise in rural building activity should be given attention and aid during 1941 and until a change in trend is evident. The present need is educational. Favorable credit arrangements or federal insurance for favorable financing of rural housing by private capital are possibilities which might greatly influence rural housing activities, but such legislation to stimulate housing would probably be postponed to launch a works enterprise after defense. In any case the accumulated need for improvement in rural housing will be met partly by present defense housing, partly by private enterprise prior to the full exertion of our defense effort, but probably will be deferred principally for after-defense work.

Rural electrification in addition to having a prominent place in this rural improvement cycle has an immediate contribution to make in a number of aspects of the program for production and preservation of food for defense and in providing more wholesome and palatable diets for rural people. Rural electrification enables farmers by means of lighting to increase the number of hours of time expended on defense effort. It also saves labor on many operations, performing better work at less cost than can be done manually. It makes possible further processing of materials, or the ready conversion of wood to fuel, which may have a high defense value. It services 115 different types of rural industries serving defense and less vulnerable to attack than centralized industrial plants. It spreads a network of power available and in use to serve communication systems for civil and military purposes and for airway radio and light beacons. The portable generating plants devised for isolated cooperative service have also been found highly adaptable to use in the rapid establishment of isolated industrial or military defense operations.

I have merely suggested fields of defense service for engineers in the agriculture effort. Speculation is not profitable on the details which might involve the service of agricultural engineers in the total defense effort of our nation to avert a world cataclysm. Nor is it possible in this brief recital to give credit to the breadth of the defense programs of public and private agencies in which agricultural engineers are employed. It is fitting, however, for us to see our patriotic place and perform our indispensable service in supplying food and other agricultural supplies for defense in an agricultural power age, conserving and making efficient use of resources of American farms, and aiding in whatever progress may be made in improving homes, the foundation stone of a nation's strength and morale. It is also fitting to prepare for a greater responsibility in leadership in the agricultural engineering educational effort now and after accomplishing defense.

Conservation Practices in Oklahoma

By W. H. McPheters
MEMBER A.S.A.E.

IN OKLAHOMA terraces are being built to stop gully erosion, reduce sheet erosion, hold more water on the field and allow it to soak into the ground, and to form permanent guide rows for contour farming. Since terraces will not hold the water evenly nor keep the soil distributed evenly over the field, we are insisting that contour farming be practiced by planting rows parallel with the terraces. We consider these two practices inseparable.

After terraces have been built and contour farming is being practiced, soil can be built back and kept on the field. In an effort to build back the soil, crop rotation is being practiced and vegetable matter is being plowed under instead of burned. We are advocating plowing in the late fall, winter, and early spring in order that more water may be soaked into the ground during the winter months and in order that the vegetable matter may be allowed to decay.

We are getting some good results in better maintenance of terraces; at least the terraces are being maintained much better than in former years. The maintenance of the terraces is very important if a soil erosion control program is to be successful.

We are advocating the use of the terrace outlet spreader wherever possible, and where it is not possible to use it, we are advising that the terrace outlets be protected with masonry or concrete structures—also that the terrace outlets be open the full width of the channel. Both channel and ridge terraces are being advocated, whichever the farmer can build the cheaper with the power and machinery available. The farmer is being urged to use the machinery which he has such as the plow, fresno, homemade terracer, small commercial terracing machine, and, where possible, the large grader. Where the terraces are built with the plow, we advocate that they not be completed in one year but that they be built in two years and two feed crops grown while they are being built. Not more than three terraces should be started at a time when the plow is used. After these three are completed, two or three more terraces can be started. We are trying to make the program of terracing as inexpensive as possible so that more of the small farmers can get their terracing done without spending very much cash.

Where there are no pastures into which to empty terrace water, we are advocating that the farmers make new pastures. In many places a small addition to a pasture may be all that is necessary.

We are advocating the building of farm ponds and are getting a great many of them built, particularly in the range program. It is our idea to get ponds scattered over the range so that the stock will not have to travel so far for water.

Paper presented before a meeting of the Southwest Section of the American Society of Agricultural Engineers at Dallas, Tex., April 1941. Author: Extension agricultural engineer, Oklahoma A. and M. College.

Research a State of Mind

THINKING is not a case of spontaneous combustion. It does not just happen to occur. The origin of thinking is some perplexity, confusion, or doubt. C. F. Kettering says, "Research is not a thing you do in the laboratory. It is a state of mind." It is an active state of mind prodded on and on in reflective thinking by intellectual curiosity and by dissatisfaction with the limitations of existing knowledge and resulting ways of living and working.—*E. A. Silver.*

Compression of Cotton at Cotton Gins

By Charles A. Bennett

Member A.S.A.E.

UNTIL the ginned cotton fiber has been packaged in suitable form to enter trade channels, the ginning processes cannot be considered as completed. On this final and very important step in ginning, the Cotton Ginning Laboratory of the U. S. Department of Agriculture at Stoneville, Miss., is conducting research under a Bankhead-Jones special research project, and is obtaining much needed engineering and technological data. The Bureau of Agricultural Chemistry and Engineering and the Agricultural Marketing Service cooperate by handling their respective phases of the investigation.

Cotton bales in the United States are now handled in three densities, measured in pounds of cotton per cubic foot of bale volume after the bale has left the press. Flat or square bales coming from plantation and public gins have usually been packed to an average density of 13 lb per cu ft; standard-density bales for domestic shipment have been the usual gin bales compressed at concentration points to an average of 24 lb per cu ft; high-density bales for export have been those which were compressed or recompressed to an average density of about 33 lb per cu ft.

Trade in flat or square bales of cotton from gins in the United States is based upon 500 lb gross weight with an allowance of 22 lb for tare; the tare includes about 12 lb for 7½ sq yd of jute bagging and approximately 10 lb for six metal ties and buckles.

The net weight of cotton fiber in a gin bale is supposed to be 478 lb. Actually there is no rigid standardization in cotton-bale weights at the gins, because the seed cotton loads may gin out to produce bales varying from 300 lb to 800 lb, and averaging about 500 lb.

Paper presented before the Power and Machinery Division at the annual meeting of the American Society of Agricultural Engineers at Knoxville, Tenn., June 1941. Author: Senior mechanical engineer, Bureau of Agricultural Chemistry and Engineering, U. S. Department of Agriculture.

Development of Cotton-Gin Presses. Early cotton-gin presses were constructed of wood with post-oak screws and heavy sweeps operated by a team of horses or mules to produce a downward thrust in the cotton box. In isolated instances, these were followed by iron-screw presses which were invented shortly before the Civil War. Later, factories engaged in quantity production of presses brought out screw presses to be driven with the motive power of the gin; these usually had a single cotton box, so positioned that only the upper half protruded above the working floor. Modern presses, except in roller ginneries, are double-box presses, so designed that one box can be filled while the bale in the other is being pressed and tied. There are, however, many single-box presses still in use in the southeastern states where individual condensers are attached to the gin stands and collecting lint flues are not employed.

Packing or tramping the cotton into the press box is a hand operation on most single-box presses, but the double-box units have employed power packers for many years. There are steam, hydraulic, and mechanical types of power packers, the types being in turn divided into subtypes according to the method of control. Hand control on all of the early types of power packers was gradually superseded by mechanical control.

The rams or plungers for the final pressing stages have been generally confined to rams of the screw and hydraulic-plunger types, but some toggle-lever presses have been tried out.

In 1935, according to the Bureau of Census reports, there were 14,414 cotton gins, of which 12,779 were active. In these establishments there were 1,342 single-box presses, over 13,000 double-box presses, and 255 round-bale presses which employ neither screw nor hydraulic rams in their production of 250-lb round bales. In 1935 about 66 per cent of the presses had hydraulic rams and the remainder were, with few exceptions, of the screw type.

It is estimated that in 1940 there were approximately 13,000 gins in the United States of which approximately 11,643 were active. Although the 1940 census reports are not yet available, it is estimated that the decrease in gins has been heaviest in the older types and that there are now about 75 per cent of hydraulic presses and only about 25 per cent of screw presses. It is doubtful whether there are now more than a

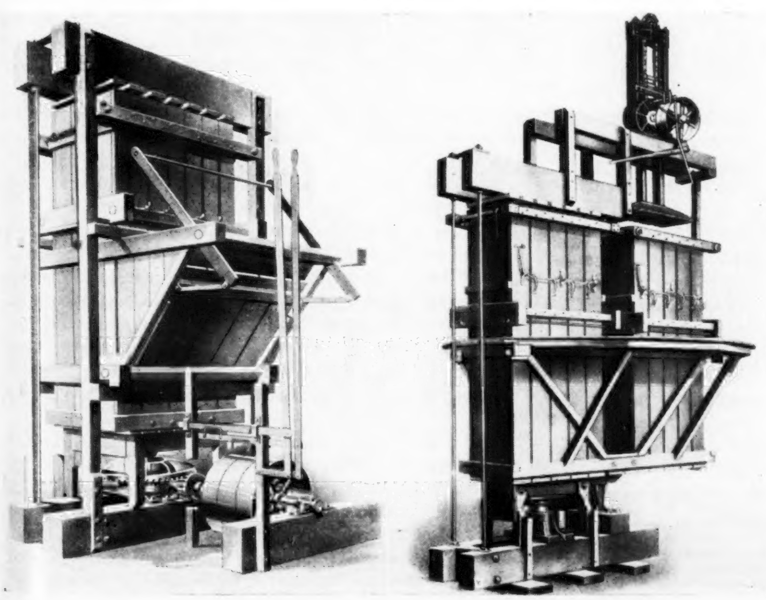


Fig. 1 (Extreme left) A wooden, screw-type, single box press. Such a press was submerged below the ginning floor line which is located on the horizontal cantilever beams upon which the box door levers are pivoted. Fig. 2 (Left) A wooden, hydraulic, double box press. The ginning floor level is flush with the center circle or middle of the cotton boxes

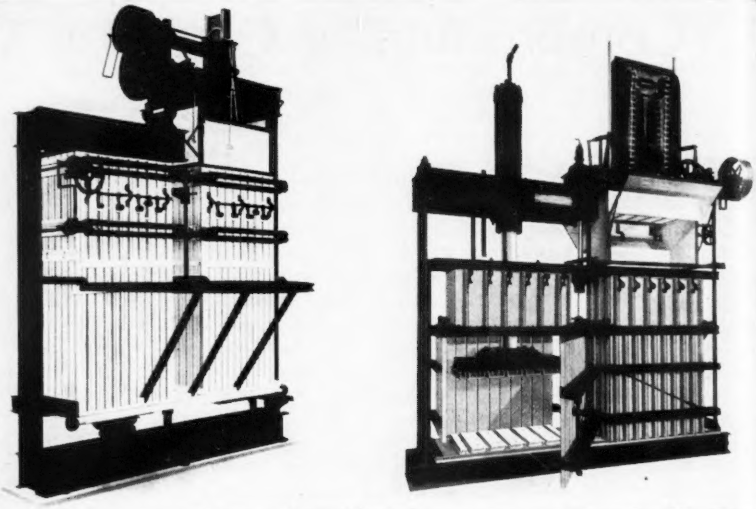


Fig. 3 (Right) An all-steel, hydraulic two-story modern press. The ginning floor line is level with the circular steel deck attached to the center of the cotton boxes. Fig. 4 (Extreme right) An all-steel, hydraulic, single-story modern press

thousand single-box press gins remaining in the country.

Present Practices with Gin Bales. The cross-section (horizontal) dimensions of cotton-press boxes in this country are almost universally 27 by 54 in.

The bales, when released from the press, expand to the average approximate dimensions of 28.5 x 56.0 x 44.4 in[1]. Freight-car loadings vary in number of bales, but will average 30 to 32 bales per 40 ft 6 in x 8 ft 6 in x 8 ft 6 in freight car, for shipment to the domestic or railroad compress centers.

The "tied-out" dimensions of bales of various types depend not only on the manner in which the ties are attached, but to some extent also on the number of ties used. Six ties are universally used on gin bales. Ties generally weigh 45 lb per bundle of 30, with buckles attached. Stock ties are 138 in long by 15/16 in wide, and have a cross-sectional area of 0.038 sq in and a tensile strength of approximately 2,700 lb per tie. Some ties are coated with black paint, others with creosote. Those coated with creosote are objectionable to the trade because they cause stains and the stain from each tie may ruin many yards of fabric.

Bale coverings may be of jute weighing 12 lb per pattern, or sugar-bag cloth weighing $10\frac{1}{2}$ lb per pattern, of cotton weighing $4\frac{1}{2}$ lb per pattern, or of other material. As the bales progress through compression establishments, the number of ties and strength of buckles used are increased.

Gin Buildings and Press Types. The arrangement of ginning machinery depends upon the type of building in which it is housed. Existing gin buildings in the United States are about equally divided between single-story structures, one and one-half-story structures having elevated press decks, and two-story structures. Single-story gins have their machinery on the ground floor and employ special types of single-story presses of recent types, or resort to older forms of construction with the lower half of the press submerged in a pit below floor level. New presses in single-story gins may be either down-packing or up-packing, and are usually of all-steel construction. Gins of the one and one-half-story type place their machinery on the ground floor with exception of the press which is elevated above the floor level and operated from a cotton deck about 5 to 8 ft above the ginning floor. The presses may be of essentially all-wood, part wood, or all-steel construction. Even in wooden presses, columns are used to unite the bottom sills and top platens. Modernization of wooden presses has led to improved locks on the doors, metal bindings on the wooden boxes, and better rams. Two-story gins employ the same kinds of up-packing presses found in one and one-half-story gins.

[1]Wright, John W., and Bennett, Chas. A. The Compression of Cotton and Related Problems. U.S.D.A. unnumbered mimeographed circular, November 1940.

Engineering Features and Performance of Gin Presses. From an engineering viewpoint, the important elements of a cotton press are (1) the condenser and packing equipment; (2) the press frame with boxes, turntable, and other incidental items; and (3) the pressing mechanism proper, which may comprise the screw and its drives, or the hydraulic ram with pump, piping, and controls.

The condenser of a cotton-gin press delivers a bat of cotton to the lint slide from which it is "kicked" into the receiving cotton box periodically between the tramper strokes which push the fiber downward past retaining "dogs" which protrude into the press boxes. Trampers make about five strokes per minute while the cotton box is being filled, and are shut off at high position when turning the box to pressing position.

Frames of cotton-gin presses may be of wood, metal, or both. The center columns are universally of metal, having square or round circular cross section, and the "sway or brace rods" on the outboard ends of the sills and platens (upper beams) are made of steel. The latest form of cotton press has a structural-steel frame throughout, with a cylindrical center column upon which the double box is pivoted with a tubular sleeve and suitable ball-bearing turntable.

The depth of cotton press boxes is about 10 ft, and the usual horizontal cross section is 2 ft 3 in by 4 ft 6 in, or 10.125 sq ft.

The actual pressing with hydraulic rams of the predominant type is accomplished with ram strokes of 7 ft or more for the conventional one and one-half and two-story up-packing presses. The plungers are of various sizes, but new press rams are standardized at $8\frac{3}{8}$ or $9\frac{1}{2}$ in diameter. They are usually of cast iron machined sufficiently to eventually become polished in operation. Casings for the plungers have been of cast iron or cast steel, but are now made of 10-in, extra heavy steel pipe, plugged at one end and capped with gland and stuffing box for the ram at the other end.

Single and double-packing glands are in use on cotton gin rams, and the new presses are equipped with overflow connections through which fluid from safety slots at the base of the ram may discharge when the pressure has reached the safety limit.

Considering normal pressing loads requiring about 1,200 psi (pounds per square inch) hydraulic pressure on

dry cotton, the conventional 8⅜-in ram develops a thrust of 33 tons as compared to 42½ tons with a 9½-in ram. The large rams are growing in favor because of their greater thrust and also because they are adaptable to the 10-in pipe casing. The follow-block, which rides upon the ram, applies pressures against the cotton of approximately 3½ to 4½ tons per square foot in the usual press box having a cross-sectional area of 10⅛ sq ft.

The construction of the experimental cotton-gin press employed at Stoneville, Miss., by the Bureau of Agricultural Chemistry and Engineering and the Agricultural Marketing Service in producing standard-density bales of 24 lb per cu ft may be of engineering interest. The major elements of this all-steel construction are shown in Fig. 5. A maximum load of 500 tons is contemplated for the three rams whose travel is slightly more than 8 ft.

One side of the press is fitted with a box 20 in wide by 54 in long by 111½ in deep; the other side is the conventional 27 in by 54 in by 111½ in in size. Bales of equal density pressed in the two boxes require different hydraulic pressures, that from the narrow box requiring about half as much as that from the wide one. Thus a reduction of 25 per cent in width has produced a reduction of 50 per cent in the required hydraulic pressure on the rams. The optimum dimensions of a cotton-press box are still unknown.

Pumping and Piping Arrangements. Present-day gin press mechanical pumps operate at speeds ranging from 150 to 250 strokes per minute. The various types in use represent vertical triplex, horizontal triplex, quadruple, and sextuple designs. The bores of the brands of pumps now extensively used vary from 1⅜ to 1¾ in; the strokes vary from 3½ to 4 in in length.

Steam pumps, found in a number of gins, have various bores and strokes. A typical steam pump has an 8½-in steam cylinder, a 1½-in water plunger, and a 10-in stroke at 150 strokes per minute with 75 lb steam working pressure. Both this pump and the hydraulic pumps previously mentioned are suitable for ram pressures up to 2,000 psi.

For the experimental standard-density press, various piping systems are being prepared. These are shown in explanatory manner by the diagrams of Fig. 6.

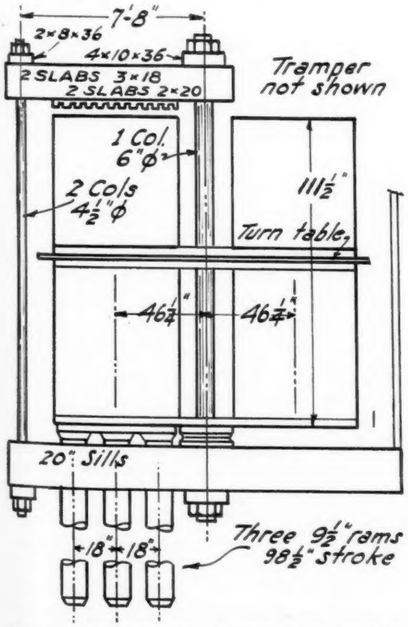
Pressing fluids may be either water or oils; the latter are preferred if they are petroleum oils of a type that does not tend to explode under high pressures. Water, because of its economy, is used by most cotton gins, but oil preserves the ram polish and assists lubrication through the packing rings.

Since rates of pumping should approach 16 gpm or more for the larger cotton gins, double extra-heavy 1¼-in pipe, with forged steel valves and fittings, is frequently used. The valves are usually manually operated, and the pumps are run continually on by-pass, no-load circuits when not pressing.

Special "knock-outs" have been invented at the Cotton Ginning Laboratory to retain low-power requirements as pressures rise, by simply cutting pump cylinders out of load service on proportionate steps of pressure.

CONCLUSION

The engineers, economists, and technologists of the U. S. Department of Agriculture are searching for the facts which bear upon the engineering and mechanical feasibility of packaging cotton in higher density 500-lb bales at the gins, and are studying the comparative costs and advantages of much higher density gin pressing, as compared to customary procedures. They also seek to determine the effect of higher densities on the spinning value of cotton; to work out the requirements for a higher density gin bale package which will best serve all needs; and to ascertain the mechanical and economic feasibility of devising cotton-gin equipment and operating methods which will insure that all the cotton in a bale is of uniform quality.



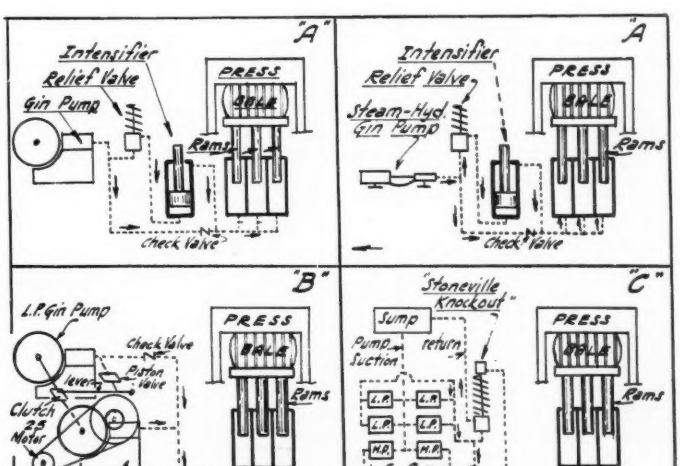


Fig. 5 (Left) Engineering diagram of the all-steel experimental, standard density press employed in research work at the U. S. Cotton Ginning Laboratory. Fig. 6 (Right) Research pumping systems on experimental U. S. cotton press. A (upper left), The motor-driven conventional gin pump operates up to 1500 psi. Relief valve then starts intensifier which finishes pressing up to 4000 psi. A (upper right), Steam-driven hydraulic gin pump operates in the same manner as indicated for motor-driven gin pump opposite. B (lower left), Compound pump, comprising low-pressure gin pump plus special high-pressure pump attachment, operates up to 1500 psi, at which point special piston valve disengages clutch to stop low-pressure pump, while the high-pressure pump completes the pressing. C (lower right), Six-cylinder, high-compression pump is arranged through the Stoneville "knockout" to by-pass low-pressure pump plungers at 1000 psi. These four low-pressure plungers idle under no load from that point, while two high-pressure plungers complete the pressing

Recommended Conservation Practices in Texas

By M. R. Bentley
MEMBER A.S.A.E.

DURING the past year a series of conferences on recommended farm practices have been held in some six places in Texas covering most of the state except the southwest. These conferences were attended by representatives of various state and federal agencies concerned with agriculture.

Practices were considered under the three subjects of field crops, pastures, and the conservation of soil and water, by three groups of men at each conference. Finally, the reports of the three groups were harmonized in a joint session at each of the six meetings. It is the purpose of this paper to summarize briefly these reports as they apply to recommended soil and water conservation practices.

Consideration was given to the matter of what sort of crop land should be terraced. A broad recommendation on this would be to terrace all land to be planted in annual crops if it slopes as much as 1 per cent. Recommendations were made for various general soil types as to what slopes should not be planted to crops. These varied from above 2 per cent to about 8 per cent. In the western portion of the state terracing was recommended for land that is nearly level as a means of conserving the rainfall. Terracing is not recommended for deep sandy land, such as shinnery sand, even though the land be used for crops.

The recommended fall along terraces varies from level with partially closed ends on the western plains to some grade not over 3 in per 100 ft in the central and eastern part of state. Where some fall is to be used, a variable grade was in some areas recommended, while in other areas it was designated as a useful means to an end, speaking literally.

Terrace spacing received little consideration, but where it did, the suggestion was made that the vertical interval be either one-half of the "land slope in feet per 100 ft plus 2 ft," or one-fourth of the "slope plus 8 ft," with a maximum horizontal spacing on nearly level land of 300 ft.

The proper size for a terrace ridge brought out considerable discussion but few figures. I believe the discussion of conservation in the black land to be heard here will bring out some figures. In general, the conclusions reached were that a terrace ridge should be high enough to keep water from running over it, and wide enough for the convenient use of the farm implements that would be used on the ridge. On account of some widths that I consider extreme, I would say "*only* wide enough," and so on, for obvious reasons that some of my fellow workers will not see.

It was decided to recommend a uniform practice of locating the terrace channel on the surveyed line to avoid trouble with performance in those cases where it does make a difference whether the channel or center of the ridge is on the line. Where the terrace is to be closed at both ends, it was recommended that the center of the ridge be on the surveyed line.

The matter of building terraces from the upper side only was considered. It was generally recommended for slopes over 2 or 3 per cent if suitable equipment was available. This method of construction does not fit in well with a revived interest in building terraces with farm plows and one-ways, particularly in the western part of the state.

Paper presented at a meeting of the Southwest Section of the American Society of Agricultural Engineers at Dallas, Texas, April 1941.
Author: Extension agricultural engineer, A. and M. College of Texas.

Terrace maintenance, or rather the lack of an adequate amount of it, came in for considerable discussion. A recommended minimum was an annual backfurrowing to the center of the ridge. In one of the area conferences it was recommended that the terrace channel be plowed out so as to leave the deadfurrow from the plowing in the terrace channel. In another area conference, it was recommended that the terrace ridge be sown annually in a close-growing crop and backfurrowed annually.

It was recommended that all tillage operations be run parallel with terraces. The tillage of unterraced crop land should be on the contour, except in the case of deep sandy land of irregular contour where it is too difficult.

With reference to strip cropping, I believe the opinion was unanimous that stripping should be practiced on unterraced land wherever it would increase the periods during the year when terraces could be constructed. Strip cropping and border stripping were recommended for west Texas wherever it would reduce wind erosion.

Except for the above uses of strip cropping, my impression in these conferences was that strip cropping was damned by faint praise.

A few general recommendations were made on what to do with crop land retired from cultivation. Generally, terracing was not recommended, except where one or two terraces would serve to divert water from crop land below, or where a limited amount would aid in gully control. In planting or cultivating desirable vegetation, contour tillage was recommended.

Pasture Land. Terracing was generally not recommended for pasture land except for diverting run-off water from cropland below, or for diverting water from gully heads. The use of spreader dams, supplemented by spreader terraces where needed, was recommended where the topography was peculiarly adapted. Ridges were not recommended. Contour furrows, preferably with furrow dams, were recommended for extensive use in conserving rainfall. Furrows are not recommended for sandy soils, nor for pastures where the vegetative cover is such that it prevents the excessive loss of rainfall from run-off. While chiseling is beneficial in many pasture soils, it is not as lasting in beneficial effect as furrowing.

Orchard Land. It was recommended that orchards be planted on the contour. The terracing of land to be planted in orchards is recommended for slopes exceeding 2 per cent. It was suggested that the trees planted on terraces should be 3 or 4 ft below the crest of the ridge.

Wind Erosion Control. Without going into the details of recommendations for the high plains on wind erosion control, the following were some of the general recommendations: (1) Use strip cropping practices; (2) leave crop residue on the land as much of the year as practicable; (3) leave high stubble on the land when harvesting forage; (4) prepare land late; (5) leave clods on the surface wherever practicable; (6) utilize any available waste material on the land, such as gin waste or barnyard manure; (7) the use of winter cover crops when moisture is available in the early fall, may be an aid on small isolated fields; (8) border strips are recommended in some areas; (9) farmstead windbreaks are recommended for adapted locations.

Engineering Aspects of Rodent Control

By F. E. Garlough

THERE are several species of field rodents that have the habit of making their burrows in the fields and in the banks of ditches and irrigation canals that give the agricultural engineer considerable trouble. The most prominent species of this group are pocket gophers, prairie dogs, ground squirrels, muskrats, woodchucks, and beavers. These animals are distributed widely over our western states and some of them throughout the eastern states. The losses caused by these rodents to crops run into hundreds of millions of dollars annually. The loss of water is a chief concern of the agricultural engineers. Rodent burrows in the embankments of irrigation canals or dykes weaken them, causing breaks which not only result in a loss of water but also in flooding valuable growing crops.

The rodent that causes the most damage and is distributed throughout the entire United States is the common house rat. By reason of its gnawing ability it is able to gain entrance into city and farm buildings and cause tremendous damage to both foodstuffs and property. This damage has been estimated for the United States at $189,000,000 annually. Of this amount $63,000,000 is on the farms, the remainder in rural towns and communities and in the larger cities.

Field Rodents. Pocket gophers are burrowing rodents that construct a network of tunnels in grain and hay fields and in range lands. Their main feeding tunnels are generally about 6 to 8 in below the surface of the ground. Along the main line tunnel, there are other tunnels some leading to the surface at the mounds of earth and others deeper into the ground to their nests and storehouses which may go to a depth of 6 ft or more, the average being 2 to 4 ft.

Pocket gophers have their own individual systems, except during the breeding season when the young are present. One of these systems may extend 800 ft or more and ramify over an acre of ground. In a field that has some slope there is danger of erosion starting and forming a bad ditch across the field. If action is not taken to stop it, it may after a few heavy rains create a ditch too wide and deep for machinery to cross. Before this happens the pocket gophers should be removed and the tunnels broken up and the slope protected with contours.

Another condition which concerns the agricultural engineer is the loss of water caused by pocket-gopher burrows in the sides and bottoms of irrigation ditches. These burrows ramifying through them greatly weaken the banks and the whole embankment may give way when the tunnels are extended too close to the water permitting it to seep through and start flowing down the runways. This results in a great loss of water and may cause heavy destruction of growing crops. It is advisable to control these rodents where they occur in irrigation sections. In El Paso County, Texas, during the past five years pocket gophers have been controlled on U. S. Reclamation Service projects which has reduced the water loss 70 per cent.

Ground squirrels, prairie dogs, and muskrats burrow in a similar manner and cause like damage unless controlled.

Paper presented before the Farm Structures Division at the annual meeting of the American Society of Agricultural Engineers at Knoxville, Tenn., June 1941. Author: Biologist, Division of Predator and Rodent Control, Fish and Wildlife Service, U. S. Department of the Interior.

These rodents and the pocket gophers may give the highway and railroad engineers headaches also, for their burrows under highways and railroad embankments may so weaken the structures that they give way. Incidents are on record of train wrecks being caused in this manner. There are methods available by which these rodents can be controlled.

The beaver takes the first prize as a rodent engineer. It is a lumberman and a dam builder. It can fell a tree, dig a ditch out from the main stream to a point near it, and thus float larger sticks and debris down the ditch to the stream across which it may be building a dam or to a nest it has constructed in the water impounded by such a dam. Sometimes the beaver comes across an irrigation canal that strikes its fancy and starts to build a dam across it, much to the exasperation of the irrigation engineer. Again it may select a stream near a highway to build a dam which backs the water over the road. This situation can be corrected by live-trapping the beavers and transferring them to a location at a higher altitude along a stream where its dam building will be a benefit by helping to hold back the water and prevent a rapid run-off.

The World-Wide Rodent Pest. The rodent that is giving not only the United States but the whole world concern is the common house rat (Rattus norvegicus). It is also called the barn rat, wharf rat, sewer rat and Norway rat. Only a few small areas in the United States are free of this pest. There are two other species of rats in this country of the black rat group. They are also known as the ship rat and the roof rat. These two species are limited in distribution, being chiefly at seaports and in the gulf states. Wherever any or all of these species are present in any number they are destructive to property and foodstuffs and a menace to public health.

Rats play an extremely important part in the spread and dissemination of several diseases because they live in close association with man and domestic stock and because they are starboarders and scavengers. They frequent alternately sewers and grocery stores, privies and pantries, run from disease infected places to non-infected places, and carry the disease organisms in their mouths, on their feet, and in their fur. There are records showing that rats have been the cause of the spread of bubonic plague, typhus fever (Brill's disease), spirochetal jaundice (Weil's disease), rat-bite fever (sodoku), food poisoning (improperly called ptomaine poisoning), trichinosis, and several other diseases that affect man.

Due to this health factor and the rat's destruction of food and property, every effort should be made to control and eventually eliminate it, if that be possible. There are three cardinal ways of controlling rats:

1 Keep all food out of their reach in so far as possible by using covered garbage cans and by not allowing edible food for them to be accessible in the backyards or in other places within and without buildings.

2 Remove all harborage by keeping trash and waste materials about the premises cleaned up and by rat-proofing buildings so they can not get inside to find hiding places and food.

3 Eliminate them immediately wherever and whenever

they are observed to be present by use of traps, gases, and toxic baits.

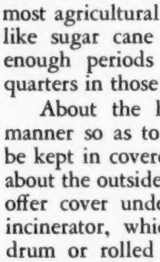
As rat-proofing buildings is the method of control that concerns the agricultural and structural engineer, only this method will be discussed in this paper.

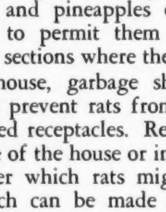
Principles of Rat Proofing. While each building presents its individual problems, there are two general principles that hold for all types of buildings and should be kept in mind when rat proofing is being considered. First, the exterior of those parts of the structure accessible to rats must be constructed of materials resistant to the gnawing of rats and all openings must be either permanently closed or protected with doors, gratings, or screens; second, the interior of the building must provide no dead spaces, such as double walls, spaces between ceilings and floors, staircases, and boxed-in piping, or any other places where a rat might find safe harborage, unless they are permanently sealed with impervious materials.

Rat Proofing on the Farm. Rat proofing on the farm sounds like an expensive and prodigious undertaking. But the cost will amount to less than the loss occasioned by rats on the same farms during a single year. In no other place is rat proofing needed more and is less often accomplished than on the farm. There are, however, rat-proof farms in almost every county in the United States and most of these belong to progressive farmers who have learned that it pays to stop the leaks which reduce profits. Rats are the cause of one of the big leaks.

Rat proofing the farm is generally limited to the area in and about the buildings for if their shelters and food supplies are cut off, they do not remain long on that farm for the fields do not have suitable harborage for them in most agricultural crops, or during the winter. A few crops like sugar cane and pineapples offer coverage for long enough periods to permit them to establish permanent quarters in those sections where these crops are raised.

About the house, garbage should be handled in a manner so as to prevent rats from feeding on it. It may be kept in covered receptacles. Refuse should not be piled about the outside of the house or in the yard where it would offer cover under which rats might live and breed. An incinerator, which can be made from a discarded metal drum or rolled up poultry netting, may be used to advantage on the farm. The piles of stove wood, manure piles, hay and straw piles near farm buildings should





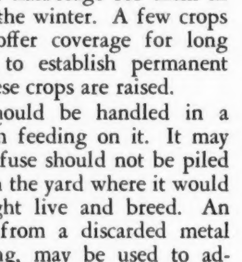
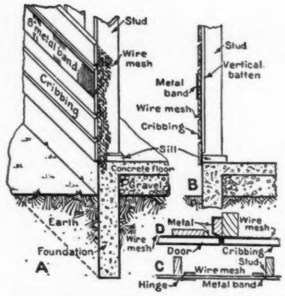


Fig. 1 (Left) Foundation and floor construction suitable for most types of farm buildings. **Fig. 2** (Center) Detail of an old barn made rat-proof with concrete foundation and floor and cement-plastered walls. **Fig. 3** (Right) Recommended construction of walls and floors of new frame barns. Cement plaster on metal lath or insulating board is applied to the inside of the studs, at least to the level of the window sills, as a better protection against rats



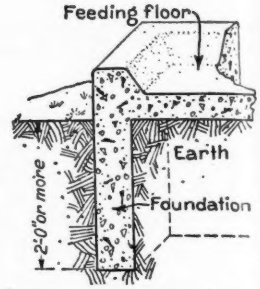


Fig. 4 (Left) Detail of corncrib construction. A, section through wall. B, section through door, which is made of cribbing on vertical battens. (The metal band on the wall extends across the door, but is cut and bent inward at the edges of the door.) C, plan of door. D, enlarged detail of jamb at closing side of door. **Fig. 5** (Right) A concrete curtain wall or apron under a feeding floor for hogs prevents raveling of earth and subsequent breaking of the slab, as well as the harboring of rats

all be watched that they do not become rat harbors. These can be piled away from a food supply and not allowed to remain in one place too long. Lumber should always be piled some distance off the ground.

Rats on the farm may find harborage during the summer months in stone walls or ditch banks near the farm buildings and during the winter months move into barn, granaries, or other farm buildings if they can find entrance. If they cannot obtain this shelter or do not have access to a food supply they move on to the next farm where they can find food and shelter. It then behooves the farmer to rat-proof those buildings on the farm containing feed for the rat or remove any harbors that may exist.

Concrete used in the construction of most farm buildings is usually the best means of permanently excluding the rat. The essential principles of rat proofing a farm building are also principles of good construction. For good rat proofing, the foundation should be concrete and extend two feet below the surface of the ground and a foot or more above the ground to protect the wooden parts of the building and also to discourage rats from gnawing through the wooden sheathing or siding. The concrete should be of a rich hard mixture for the sharp rodent incisors will cut through a weak concrete. Fig. 1 shows a foundation and floor suitable for most types of farm buildings.

Rat Proofing Barns. Since it is not possible to entirely cut off their food supply in a barn where stock are fed, it is highly important to remove rat harbors. These are generally found about stall partitions, wooden mangers, beneath wooden or dirt floors, and under rejected foodstuffs allowed to accumulate in mangers. In old barns the wooden and dirt floor should be replaced with concrete, stall partitions made solid and the mangers raised a foot or more above the floor. The modern barns have eliminated their rat problem by having concrete floors, concrete or metal mangers, metal stanchions and rat-proof partitions in horse barns.

Old barns having wooden floors supported a few inches above the ground on wooden girders and posts should be rat-proofed with a concrete foundation and floor as shown in Fig. 2.

Some old barns have hollow walls which are ideal rat harbors. The inner siding should be removed, or concrete should be poured into the hollow spaces filling them to a height of eight to ten inches above the sill, or a strip of galvanized metal, two feet wide, may be securely fastened around the inside wall just above the sill.

Within the barn all the grain bins should be made rat-proof. They should be lined *(Continued on page 291)*

Controlled Drainage in the Northern Everglades of Florida

By B. S. Clayton and L. A. Jones
MEMBER A.S.A.E. FELLOW A.S.A.E.

THE FLORIDA Everglades contain about 4,000 sq mi of peat soil, most of which is underlain with porous limestone. Prior to drainage this sawgrass marsh was kept in a near saturated condition by rainfall and the seasonal overflow from Lake Okeechobee. The surplus lake water is now diverted directly to the ocean, and large canals carry away much of the rainfall, thus lowering the water table and causing soil loss through subsidence and fires. The Soil Conservation Service is now making a study of the Everglades area with the purpose of finding means of decreasing these losses.

Most of the farm land of the Everglades is located in the northern portion near Lake Okeechobee. The peat deposit varies in depth from a few feet near Moore Haven to 12 ft near the east side of the lake. The greater portion of the peat now in use has a depth of 6 to 7 ft. The cultivated area of the northern Everglades covers about 90,000 acres and approximately 27,000 acres of this is planted in sugar cane. Most of the remainder is used for truck crops such as beans, peas, cabbage, potatoes, tomatoes, and celery. The region is particularly adapted to large unit farms and the use of farm machinery. The farming period extends from early fall to the latter part of May.

Soils. The organic soils include three types commonly designated as plastic or Custard Apple muck, willow and elder land, and sawgrass peat. The Custard Apple muck was formed from the sedimentary deposit of succulent water plants. The mineral content or ash is usually 40 to 60 per cent of the dry weight. This soil type covers about 20,000 acres and lies close to the rim of Lake Okeechobee. The willow and elder land covers a belt between the Custard Apple and sawgrass peat soils. It is basically a sawgrass type with a thin layer of plastic muck below the surface. This land was originally covered with a growth of willow and elder bushes, hence the name.

The sawgrass peat was formed from the partially decomposed residue of sawgrass. The ash content is approximately 10 per cent of the dry weight. A cubic foot of this soil, when saturated, is a little heavier than water, and after drainage retains water equivalent to 75 per cent of its moist weight. This soil has a sufficient supply of nitrogen, but is deficient in potash, phosphorus, and minor elements. These are added as fertilizers. Due to the mild climate two to three crops may be grown in a year.

Pumps. The early plans for reclamation of the Everglades were based on a gravity system of drainage, but due to the flat topography of the land and loss of elevation by subsidence, it was found necessary to use low-lift pumps to secure adequate drainage. Nearly all land now in use is served by pumps. The cost of reclamation including ditches, levees, and pumps has varied from $25 to $40 per acre, depending on the cost of the pumping plant and capacity of the drainage system.

Paper presented before the Soil and Water Conservation Division at the annual meeting of the American Society of Agricultural Engineers at Knoxville, Tenn., June 1941. Authors: Respectively, associate drainage engineer and chief, division of drainage, Soil Conservation Service, U. S. Department of Agriculture.

The larger pumping units use the Wood screw-type of pumps of 30,000 to 60,000-gal capacity, and most of the smaller units use the vertical turbine type of 5,000 to 30,000-gal capacity. These pumps are usually driven either by Diesel engines or ignition engines equipped to burn distillate fuel. The pumps are so arranged that water may be pumped into the drainage unit when needed.

Records on four plants with Wood screw pumps and Diesel engines showed an average annual operation period of 40 to 68 24-hr days, the time depending largely on the rainfall and seepage into the pumped area. The total cost of operation of these plants varied from approximately $1.50 to $2.50 an acre per year, according to the size of pumps used. This cost includes fuel, lubricating oil, labor, maintenance, and fixed charges. The average static lifts are about 4 ft and the maximum lifts seldom exceed 6 ft. A six-year record at each of these four plants showed an average annual depth, pumped from the areas served, varying from 2.3 to 4.4 ft. The larger amount was due to a higher water table outside the area served, which increased the amount of seepage into the pumped land.

For a number of years the total evaporation and transpiration from cane and other crops has been measured at the Everglades Experiment Station. These results indicate that the average evaporation from a pumped area growing largely sugar cane is approximately 3.5 ft per year. The rainfall for the six-year period covered by the pumping records averaged about 4.4 ft. The depth pumped plus the depth removed by evaporation was greater than the rainfall for all four pumping plants. This difference is a rough indication of the seepage into a pumped area. The six-year record at one of the pump units showed an average annual seepage inflow of about 3.5 ft. The water table in the land outside this unit was usually high, hence the greater depth of seepage.

The pumping plants of the northern Everglades have capacities of from 1 to 3 in in 24 hr over the area served. Experience indicates that a capacity of 2 or 3 in is desirable for areas of several square miles, as one excessive rain may cause large losses of vegetable crops. For large areas a smaller rate of run-off would suffice, as excessive storms seldom cover a large area or continue over a long period of time.

The average annual rainfall in the northern Everglades varies from 50 to 58 in, but approximately 60 per cent of this occurs during the four-month period from June to September when farming operations are at a minimum. A 15-year record at the Everglades Experiment Station indicates that rains of 2 in or greater have averaged four per year; that rains of 3 in or greater will probably occur 15 times in a ten-year period, and that rains of 4 in or greater will probably occur five times in a ten-year period.

When the water table is 2 ft deep, it requires nearly 4 in of water to saturate the soil. After a few years of cultivation and weathering, the top foot of soil becomes more dense and the downward movement of the water is retarded. Surface drainage then becomes of more importance.

This may be provided by plowing toward the center, and thus creating a small slope to the ditches on either side.

Ditches. The ditch systems of pumping districts have laterals a half mile apart. These are usually 6 ft deep with slopes of one-half to one. Peat will stand on a very steep slope and some ditches have been dug with sides almost vertical. The normal slope of the land is 2 to 3 in per mile, and ditch capacity calculations are usually based on a 3-in-per-mile slope. Velocities are necessarily very low. Farm ditches are spaced from 1/8 to 1/4 mi apart and discharge into the district laterals 1/2 mile apart, thus dividing the farm into 40 to 80-acre units. The 1/8-mile spacing of farm ditches is the more common. If a wider spacing is used more care should be given to surface drainage.

A ditch system soon deteriorates in capacity unless regular maintenance is provided. In peat soil a soft sludge will accumulate in the bottom of ditches and reduce the effective depth by a foot or more. This is best removed with a pump type cleaner which is moved along the ditch. A small dragline machine with a clam shell bucket is also much used for ditch cleaning. Hyacinths, water lettuce, and a species of moss readily grow in the ditches and greatly reduce their capacity.

HYACINTHS SHOULD BE REMOVED BEFORE GROWTH HAS COVERED MUCH OF THE CHANNEL

During the past year a series of measurements were made in order to determine the retarding effect of hyacinths in one of the large outlet canals. A half mile slope course was laid off along one of the larger canals with a 60-ft top width and a 10-ft depth of flow. The bottom portion of this channel was dug about 5 ft into rock. Several measurements were made with the channel clear of hyacinths. After the surface was covered with a dense growth of hyacinths another set of measurements was made. The result showed a decrease of approximately 60 per cent in ditch capacity. Hyacinths and other water plants are commonly removed with a small dragline using a bucket with opening in the back to drain off water. Hyacinths should be removed at regular intervals of time before the growth has covered much of the channel. An allowance of at least a dollar an acre per year should be provided for ditch and levee maintenance.

Levees. Peat soil is a very light material with which to build levees, and if they are not well built, slides sometimes occur. A puddle trench should be dug near the center of the levee and refilled to prevent seepage through cracks in the peat beneath the base. The top of the levee, after shrinkage, should be at least 2 ft above the maximum water level on the outside. It is usual to increase the levee height 30 per cent to allow for shrinkage. The soil to build the levee should be taken from the outside, as this will decrease the danger from slides. It is also good practice to sod the levee with grass rather, then let it be covered with a growth of weeds and brush. This will reduce the danger from fires. On account of this elevation above the general surface, peat levees are particularly subject to fire damage.

Mole Drains. Mole drains between farm ditches are generally used for subdrainage. These are usually spaced 12 ft apart and 30 in deep. They are formed by drawing a 6-in bullet-nosed cylinder through the soil. The resulting hole is about 4½ in in diameter. The cost is small; probably about 50c per acre. The mole lines increase the movement of seepage water toward the ditches and help to maintain a more uniform water table. Cleaner mole lines will result if the water table is held below the proposed depth while moles are being installed.

Water Table. For a number of years experiments have been in progress at the Everglades Experiment Station to determine the effect of water-table depth on crop yield. Water-table depths of 1 to 3 ft are being maintained in a series of eight plots of 80 by 210 ft each. Final conclusions must await completion of the project. However, the indications are that most truck crops give very good yields on an 18-in water table. Slightly lower yields usually are obtained on deeper water tables. The one-foot water table is too high for most crops with the exception of certain varieties of sugar cane and grasses. Overhead spray during the dry portion of the year had little or no effect on crop yields. Moisture tests indicate that a sample of peat soil extending from the surface to the water table is about 75 per cent water. However, the top portion of the soil which is kept pulverized by cultivation may become unduly dry during periods of little rainfall, and additional moisture may be needed at time of planting. At such times additional moisture can be supplied by raising the water table by use of the pumps.

Any large field will vary a few inches in elevation, also the slope of the water surface along the ditches will cause some difference in elevation relative to distance from the pump; hence it is not possible to hold an entirely uniform water table. However, if the pumps are carefully operated, the table can be held to an average minimum depth of two feet. At times of heavy rains the water table would be less than 2 ft deep, and during long dry spells it would be necessary to pump water back into the ditches to maintain the desired level.

SUBSIDENCE OF SOIL IN NORTHERN EVERGLADES DUE TO ACTION OF AEROBIC BACTERIA

Subsidence. The cultivated lands of the northern Everglades have subsided approximately 5 ft since drainage began about 26 years ago. The present rate of loss is approximately an inch per year. Much of the early loss in elevation was due to compaction in the top 18 in of soil and probably some shrinkage of the colloidal portion. The continued loss in later years is mainly due to slow oxidation resulting from the action of aerobic bacteria. This loss can be reduced by maintaining a high water table.

The subsidence on the water table plots at the Everglades Experiment Station has been carefully measured each year. Each plot is divided into three parts on which sugar cane, truck crops, and grasses or other forage crops have been grown. A three-year record of subsidence shows the following average annual losses:

Water table depth in feet	Annual subsidence in feet
1.03	0.03
1.52	0.06
1.98	0.08
2.54	0.11
2.80	0.13

The data when plotted fall close to a straight line which intercepts the depth axis about 6 in below the ground surface. It appears that the losses are directly proportional to the distance from the water table to a point about 6 in below the surface. It is the top 6 in which undergoes the greatest change due to cultivation and weathering.

Under similar conditions of drainage, virgin land will lose elevation almost as rapidly as cultivated land and a comparison of the dry weights of the respective soils indicates that the actual loss of soil mass is a little greater in the virgin land. Idle land *(Continued on page 291)*

The "Unit-Operations" Principle Applied to Agricultural Engineering Laboratory Instruction

By L. M. K. Boelter and H. B. Walker
FELLOW A.S.A.E.

LABORATORY instruction forms an important section of engineering training. The content and organization of the laboratory sequence must complement and supplement the lecture and recitation courses.

Many experimental illustrations of the classroom work may be made available in a "library" of apparatus, (this terminology is used to distinguish this type of work shop from the conventional laboratory) such as is employed in the Rosenwald Museum in Chicago or the Deutsches Museum in Munich. Here the machine or process equipment would be adequately instrumented and would be available for operation at all times. A touch of the button by the student would inaugurate a sequence of operations designed to illustrate the principles of operation and the operating characteristics. The student would record such data as were needed to compute the behavior of the system under observation. The principles of instrumentation and control could be illustrated in a similar manner. Certain small self-contained machines and process equipment could also be arranged for lecture demonstration.

Both of the modes of instruction noted above will relieve the engineering laboratory of a large routine load. Further, it would appear that instruction in the skills, in fabrication, assembly, maintenance, repair, and routine tests must be relegated to a minor role (or entirely omitted) in the training offered by the engineering college to the bachelor of science candidate. The skills must be acquired by many of these men, but facilities for instruction therein must be provided elsewhere.

The remaining function of the laboratory (if the other functions are supplied elsewhere) is to provide experiences in the experimental analysis and synthesis of machines and process equipment. Experimental analysis can best be provided by the utilization of the unit-operations[1]* principle originally suggested for chemical engineers[2].

Laboratory apparatus is designed to illustrate a particular principle and phenomenon[3]; all other force fields are reduced to a minimum. The unit-operations apparatus must be predictable analytically by the student with reasonable precision in order that confidence be generated in both the experimental and analytical methods. Adequate prediction implies that the experimental system (henceforth in this paper "system" will be the general term used to denote the machine, process equipment, etc.) does not differ appreciably from the ideal system (mind picture of the system). The apparatus should be small; large enough, however, so that it can be adequately instrumented. The laboratory equipment should resemble actual equipment sufficiently closely that the student can recognize the application of the phenomenon to the latter.

Experimental synthesis can be accomplished through tests of complete machines, process equipment, and plants. Finally, an experimental research task (or thesis) will provide a fitting climax of experiences in synthesis for the student.

The force fields included in the field of agricultural engineering are thermal (heat and mass transfer, thermodynamics) and dynamical (mechanics of fluids and solids, elasticity) in nature. Electrical and magnetic fields play a lesser role in agricultural engineering; however, they must be utilized in precise instrumentation and must be considered in connection with power tranfer and as one source of radiant energy. The primary unit-operations may be deduced by a consideration of these force fields. In addition, the operations of forming, cutting, and heat-treatment of industrial materials, transportation, adsorption, absorption, size reduction, separation, and filtration appear in the machines and apparatus with which the agricultural engineer works. Finally, mensuration and instrumentation, and the properties of materials require attention.

The various primary operations may each be subdivided into secondary operations. For instance, various aspects of conduction, convection, and radiation for unidirectional and periodic steady state heat flow, as well as transient phenomena, are included in the sequence[3,4,5,6,7,8,9,10,11]. The secondary operations may often be illustrated in lecture demonstrations, or the student may be assigned to perform a number of the experiments in one afternoon.

After the student has acquired experience in a number of primary operations (and the corresponding secondary operations), he should be given the experience of synthesis, namely, the application of the particular operations to a machine or a process. The experiment involving synthesis should not be delayed too long.

In this paper a complete set of experiments and the description of the corresponding apparatus cannot be given. Partial descriptions may be found elsewhere[1,3,20,21].

A DESIGN OF UNIT-OPERATIONS EXPERIMENTS IN AGRICULTURAL ENGINEERING

Agriculture[12] is concerned primarily with the production of raw products for food (grain, fruit, meat, vegetables), for shelter (lumber, fibers), for clothing (textiles), and to a partial extent for industrial purposes (newspaper pulp, linseed and soybean oil, plastics). The unit-operations of agricultural engineering are here defined chiefly with respect to the raw material, and are as follows: thermodynamics, heat transfer, fluid flow, mass transfer, adsorption, absorption, evaporation, dynamics, power transfer, size reduction, separation, filtration, orientation, gaging, transportation, and storage. These are the unit-operations of chemical, mechanical, and electrical engineering. A few illustrations of some of these operations will be included in this paper.

A typical illustration of dynamics, gaging, and separation (cutting) is the vibrating knife beet topper[12]. Raw processing includes the removal of the tops and the recovery and preservation thereof. Field topping may be accomplished by means of a horizontal knife which is vibrated at the optimum frequency and amplitude for a given forward velocity. The horizontal force exerted by the knife must be less than the resisting force of the ground (which

Paper prepared especially for AGRICULTURAL ENGINEERING. Authors: Respectively, professor of mechanical engineering and professor of agricultural engineering, University of California.

*Superscript figures indicate references cited at the end of this paper.

AUTHORS' ACKNOWLEDGMENT: The authors are indebted to Prof. Roy Bainer for his kind criticisms.

supports the beet in position); otherwise the beet will separate from the top along the 45 deg shear plane. The optimum operating conditions (amplitude times frequency) are determined by the measurement of the force required to move the knife through test beets, which varies with the forward velocity to the 0.75 power and should be less than 25 lb. The knife is excited by means of an eccentric driven from the wheels of the topper.

Field measurements yielded the result that the distance from the top of the beet (the contour followed by the finder) to the datum (the mean between the furrow and the ground adjacent to the beet) varies almost linearly with, but at a greater rate than, the distance from the lowest leaf scar to the ground datum. A variable cut mechanism was devised. Field tests yield extremely favorable performance, the per cent top tare and the per cent topping loss being comparable to hand topping.

Another application of dynamics and separation (including cleaning) is the oscillating beet lifter. After the beets have been topped and loosened by means of a plow (but the tap roots are not broken), two toed-in horizontal rods located several inches below the ground are drawn along the row, one on each side of the beets. These rods are oscillated at the proper frequency and amplitude for a given forward speed and toe-in. The beets are thus lifted from the ground in a series of small increments and are delivered to the jaw provided by two tapered, flexible rubber rolls. The beets are recovered clean, free of clods, and are elevated to a conveyor. Both of these illustrations reveal the importance of the knowledge of beet and soil properties and of the technique of mensuration.

Other size reduction operations (in addition to cutting) are slicing, grinding, beating, chopping, rolling, crushing, and pulverizing. These operations differ in the manner in which the force is applied to the specimen and the manner in which it resists size reduction. The object of the size reduction, as well as the characteristics of the specimen, fixes the manner in which the operation is effected. For instance, it has been demonstrated that certain feed grains with hard coats need only be broken and need not be ground fine[13]. An adequately designed experiment will reveal the forces (torques) necessary to effect the required size reduction operation as a function of speed and quantity. The characteristics of the product, as well as the feed, will be determined (often by separate experiment). Sizing of the product and the feed serves as an illustration of one of the separation operations. With time an adequate definition for each suboperation will emerge. The suboperations listed are probably not independent of each other.

The separation operation is exemplified by rubbing, beating, screening, vibrating, combing, threshing, gas or liquid flotation, and sorting[12]. The sizing operation may be thought of as either a gaging or a separation process. A description of one separation process follows:

A unique bean thresher[14] has been developed in which the harvested beans (straws and pods) are fed into the jaws formed by two rubber rolls which are both rotating, but at different velocities. A unit-operations experiment would involve the determination of the torque necessary to effect separation of the bean with respect to the pod (excluding the torque required to rotate the unloaded rolls) for different moisture contents and degrees of ripeness of the feed, as well as for different feeds, feed rates, relative velocities, roller gap spacing, and roller resilience. The characteristics of the product would be used as the criterion of the effectiveness of the operation.

The production phase of agriculture (after the soil has been prepared) includes sowing, planting, thinning, hoeing, and irrigation. One secondary or suboperation of planting is gaging. Laboratory tests on commercial chain-feed, single-seed and plate planters[15] yield spacing distribution which approximately follows the Gaussian Function. An excellent student experiment may be developed in which complete laboratory data on this operation (dropping the seed on greased boards) may be compared with the corresponding field spacing.

The mass transfer operation which includes drying is intriguing because the resistance appears to change with the wet and dry bulb of the drying air, as well as the instantaneous magnitude of the moisture content of the specimen. A unit-operations experiment involves the drying of single prunes (of various initial moisture content and surface area to volume ratio) at various rates in air at different states. The same operation should be repeated in batch and continuous driers.

In this brief paper the primary unit-operations will not be discussed completely. For instance, soil plowing consists of slicing (cutting), elevating, inverting, (turning), and pulverizing[16,17]. The storage operation includes siloing, piling, stacking, baling, housing, etc.; while transportation includes raking, conveying, batch hauling, lifting, etc. Another method of subdividing the operations of agricultural engineering presents tillage, seeding, harvesting, processing, irrigation, and pest control as the primary operations. Thorough analysis of the results of unit-operations experiences will aid in the classification of the various primary and secondary operations.

CONCLUSIONS

The unit-operations (also termed the unit-principle[18]) method of laboratory instruction is equivalent to the mode of analysis employed in physical instruction. The student is given the opportunity to note the experimental interrelation of variables in a system which is simple, in which the independent variables are few in number and are readily controlled. These actual systems yield readily to analytical attack for they represent closely the ideal system (thought models) upon which the elementary analysis is based.

The student must be given experimental experience in the synthesis of unit-operations as applied to actual machines or processes in order to accomplish a complete engineering educational sequence.

REFERENCES

[1]Boelter, L. M. K., "Mechanical Engineering Laboratory Practice," Jour. of Eng. Ed. 26:9, pp. 747-754, May 1936

[2]Lewis, W. K., and Haslam, Robert Thomas, "Study of Chemical Engineering by the Unit-Operation Method," Serial no. 24, M. I. T., July 1922

[3]Seban, R. A., "Unit-Operations Apparatus in Mechanical Laboratory Instruction," Jour. Eng. Ed. vol. XXXI, no. 3, pp. 213-224, November 1940

[4]Cherry, V. H., Davis, D. D., and Boelter, L. M. K., "A Mechanical Integrator for the Determination of the Illumination from Diffuse Surface Sources," Ill. Eng., vol. 34, no. 9, p. 1085, November 1939

[5]Boelter, L. M. K., Cherry, V. H., and Johnson, H. A., "Heat Transfer Notes," Univ. of Calif. Syllabus Series, April 1940, University Press, Chapter XVIII

[6]Ibid. p. V-1

[7]Lee, Allyn, Nelson, W. O., Cherry, V. H., and Boelter, L. M. K., "Pressure Drop and Velocity Distribution for Incompressible Viscous Non-Isothermal Flow in the Steady State Through a Pipe," Proc. of the 5th Int. Cong. of Appl. Mech., 1938, pp. 571-578

[8]Heat Transfer Notes, p. VII 2-3, p. VII 13-15

[9]Ibid. p. V 35-36

[10]Ibid. Chapter VI

[11]Boelter, L. M. K., and Cherry, V. H., "The Measurement of Heat Transfer by Free Convection from Cylindrical Bodies by the Schlieren Method," Heat. Pip. & Air. Cond., Jour. Sect., vol. 44, pp. 499-512, October 1938

[12]Boelter, L. M. K., "Basic Engineering Factors in Agricultural Technology," Mech. Eng., vol. 62, no. 3, pp. 226-230, March 1940

[13]Fairbank, J. P., Gordon, G. E., and Rochford, L. H., "Feed Grinding and Feed Mills," Ag. Eng. Inf. Series No. 9, Univ. of Calif., Ag. Ext. Service

[14]Bainer, Roy, and Borthwick, H. A., "Thresher and Other Mechanical Injury to Seed Beans of the Lima Type," Bulletin 580, Univ. of Calif., Ag. Ext. Sta., July 1934

[15]McBirney, S. W., Univ. of Calif., Davis, "Planter Tests in California," 1939-40, unpublished

[16]Nichols, M. L., and Kummer, T. H., "A Method of Analysis of Plow Moldboard Design Based upon the Dynamic Properties of the Soil," Trans. A.S.A.E., 26, pp. 58-60, 1932

[17]Nichols, M. L., and Reed, I. F., "Physical Reactions of Soils to Plow Moldboard Surfaces," Trans. A.S.A.E., 28, pp. 14-17, 1934

[18]Berggren, W. P., "The Unit-Principle of Laboratory Instruction," presented before the Pac. Southwest Sect. S.P.E.E., Los Angeles, Calif., December 1937

[19]Not published. Author's address, Univ. of Calif., Davis, Calif.

[20]Zimmerman, O. T., and Lavine, Irwin, "Unit-Operations Laboratory Equipment," Univ. of North Dakota, 1940

[21]Boelter, L. M. K., "Application of the 'Unit-Operations' Principle to Mechanical and Agricultural Engineering Laboratory Instruction," presented at the 48th annual meeting of the S.P.E.E., Berkeley, Calif., before the Chemical Engineering Section, 1940

Engineering Aspects of Rodent Control

(Continued from page 286)

with sheet metal, also the lids should be made of metal and constructed so as to fit tightly.

An effective rat-proof construction of a wall for a new frame barn is a wooden sill resting on a concrete foundation which extends a foot or more above the ground. On the outside of the studs is the sheathing and siding and on the inside up to the level of the window sill is cement plaster or metal lath which joins closely with the concrete floor at the lower edge and is flush with the window sill at the upper edge. This sill should extend all the way around the wall so as to block off the space between the walls (Fig. 3).

Rat Proofing Corncribs. The corncrib is the one building on the farm above all others that needs rat proofing. In one southern state a survey showed an average loss of five per cent of the corn in storage. In one crib during the winter there was a loss of 500 bu of corn. When building a corncrib it is good insurance to make it permanently rat proof. Fig. 4 shows one type of construction that is effective. The galvanized hardware cloth recommended should be made of 12 or 15 gage wire and two or three meshes to the inch. The foundation and floor should be concrete.

Old cribs supported on posts about two feet from the ground may be made rat proof by having posts covered with sheet metal or disks at the top extending at least nine inches out from the posts. Washtubs inverted over the top of the posts make convenient rat guards.

Poultry houses can be made rat proof by use of concrete floors and concrete walls extending up two feet or more above the ground. The wooden superstructure may then rest on the concrete wall. If a wooden floor is used, it should be two feet above the ground. All the fixtures inside the house should be constructed so as not to provide shelter for rats under or behind them.

Feeding floors for hogs should be made of concrete. There should be a concrete curtain wall extending two feet or more into the ground and a foot or more above the ground built in solidly with the floor. This prevents rats from burrowing under the floor and establishing a harbor near a good food supply. This is a favorite location for them (Fig. 5).

To prevent damage from rodent pests those charged with the construction of farm structures whether they be irrigation ditches and canals, or residences or any other farm buildings, careful consideration should be given to ways and means of preventing losses caused by the rodents. The best and cheapest insurance is to build against them. It is better to have rats on the outside looking in than on the inside carrying out.

AUTHOR'S NOTE: Detailed information regarding rat proofing and the control of rats and other rodents are found in several bulletins of the U. S. Department of Agriculture. "Rat Proofing Buildings and Premises", Farmers' Bulletin No. 1638; "Rat Control", Farmers' Bulletin No. 1533; Public Health Service Supplement No. 131, "The Rat and Rat-Proof Construction of Buildings", and "Pocket-Gopher Control", Farmers' Bulletin No. 1709.

Controlled Drainage in the Northern Everglades of Florida

(Continued from page 288)

should be kept as near saturated as possible and intensive drainage should not be established before the need for new land arises.

Most of the virgin land in the northern Everglades has subsided from 3 to 4 ft below original elevation. This was caused by diversion of the Lake Okeechobee overflow and the partial drainage which the large outlet canals afforded. Field lines indicate that when such land is taken into pumping units and cultivated, a further subsidence of 15 to 18 in will occur after ten years of use. This loss in elevation should be anticipated in designing the drainage works.

Seepage. As previously mentioned, a considerable amount of water enters the pumping districts through seepage. A deep, narrow trench near the inner toe of a levee will depress the seepage gradient. Seepage tests on samples of sawgrass peat in 4-in tubes show a rapid rate of seepage in a vertical direction but a very slow movement in a horizontal direction. This difference in rates is probably due to the vertical position of the partially decayed sawgrass roots from which the soil is largely made. Water-table profiles between drainage ditches also indicate this difference in seepage rates. The curves are very flat over the major portion of the space but slope sharply downward near the ditch banks. The peat deposit is generally underlain with porous limestone or marl in which layers of sand and fine shells occur. It appears that the seepage moves quite freely through the rock or sand and thence vertically through the peat deposit. After a period of weathering and cultivation, the top 18 in of soil becomes more dense and the dry weight increases to about twice the original weight. After this change occurs, the seepage rate through the top layer is much retarded and surface drainage becomes of more importance.

Due to the low pumping lifts and low cost of reclamation in the peat lands of the northern Everglades, good water control can be secured at very reasonable cost. However, a well-designed system is the first essential and a second essential is proper maintenance of ditches, levees, and pumps. The pumps should then be operated with sufficient continuity to maintain a near constant water level in the pump canal. A well-designed and operated drainage system may save sufficient crop loss to pay for itself in a single season.

A Summary of Barn Hay Curing Work

By John A. Schaller
Member A.S.A.E.

HAY making is a very important farming operation in the United States. The usual procedure in making hay by field curing is to cut the hay in the morning, windrow it about midday, and put it in the barn when the moisture of the hay has been reduced to approximately 20 per cent. This method of curing has three principal disadvantages: (1) There is considerable loss of leaves by shattering; (2) there is danger of considerable damage by rain in some sections of the country; and (3) the quality of the hay is lowered due to sunburning or bleaching.

With about 50 in of rainfall a year, the southern states have some of the nation's best hay *growing* weather and some of the worst hay *curing* weather. Therefore, with proper attention given to the preparation of the seedbed, seeding, and fertilization, the successful growth of a hay crop is almost certain, while the harvesting of the hay is a relatively important problem. This situation is a great obstacle to the soil conservation program, which relies to a large extent upon the use of cover crops to provide humus and to prevent erosion and leaching of soils.

Through several years of testing, a method of barn-curing of hay was developed jointly by the Tennessee Valley Authority and the Tennessee Agricultural Experiment Station, involving low first cost and low operating cost to complete the curing of hay in the barn after taking advantage of several hours of field curing. Briefly, the barn-curing system consists of specially constructed wooden air ducts on the hay mow floor. Partially dried hay (40 to 50 per cent moisture content) from the field is stored as usual in the mow, over the air ducts. A blower or fan, driven by an electric motor connected to the air ducts underlying the hay forces air through the hay and removes the moisture. A blower is used capable of delivering air at approximately 8 cfm for each square foot of mow floor area. The accompanying drawing shows a typical installation, in which the motor and blower are housed in, so that the air source is from the outside. Either the centrifugal or propeller type blower can be used.

The most promising method of automatic control for the curing equipment embodies the used of a humidistat and a time switch connected in the control circuit of the motor. The humidistat, located outside the barn, will start and stop the motor, depending on the dryness of the air. In the morning, as the relative humidity decreases with the warming up from the rising sun, the blower is started. Similarly, as outside relative humidity rises when the sun sets, the motor is stopped. A thunder shower will stop the motor until the air is dry enough for further blowing. The time switch is set to start and stop the motor for short operating periods during the night for the first few nights to prevent overheating, or for any time intervals desired by the operator.

In using this barn-curing system, a farmer can do two things: (1) Eliminate the weather risk and (2) make a superior quality of hay, with an investment cost of between \$250 and \$350 for blower, motor, lumber, electrical supplies, control equipment, etc., and with an average operating cost of only 39 kwhr per dry ton. Further, he can do all this without changing his usual haying operation.

From a number of analyses made of barn-cured and field-cured hay, the barn-cured hay averaged four times as much carotene, three times as much vitamin A, 2.3 per cent more leaves, and 19 per cent more green color than field-cured hay.

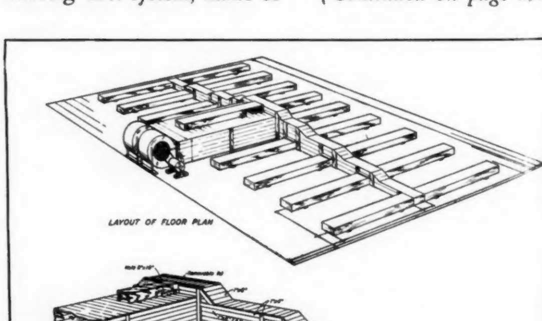
Use of the barn-type hay-curing system has spread rapidly during the past two years. At present 13 systems are in operation on farms in Alabama, Tennessee, Virginia, Ohio, Connecticut, Rhode Island, and Pennsylvania. Two of the largest installations are in Ohio and Connecticut.

The hay curing system in use on the Harold Anderson farm, Maumee, Ohio, is an adaptation of the barn-curing principle for curing chopped hay. Here a slatted floor is used instead of the usual built-up duct system. The floor over the 2x12-in joists, which run the long way of the barn, is slatted. By using 1/4-in plywood ceiling underneath the joists, the spaces between the joists serve as air ducts. Dampers in these air ducts near a 3x7-ft main delivery duct, across the middle of the barn, regulated air flow. Twin-six blade, 36-in propeller fans mounted on the side of the barn at one end of the delivery duct forced artificially heated air through the chopped hay above.

A curing system on the George Pratt farm, New Milford, Connecticut, covers a mow floor area of 36 by 120 ft, or 4320 sq ft. Four large butterfly valves in the main duct make it possible to use only parts of the system at one time, if desirable. A 48-in propeller type fan driven by a second-hand automobile engine forces heated air through the hay. The fan unit is tied into a cinder block heat chamber in which is located a wood-burning furnace.

Artificial heat is also used in connection with the barn-curing operation on the R. G. Stevens farm, Dublin, Virginia, where a stoker and furnace have been installed to furnish heat to radiators enclosed in the air duct between the blower and the duct system on the 16 by 60-ft mow floor.

Roselle Leete, Coudersport, Pennsylvania, is using a slatted floor-type system for curing loose hay. The ventilating duct system, made of *(Continued on page 295)*



Typical installation for the barn curing of hay

Paper presented before a meeting of the Southern Section of the American Society of Agricultural Engineers at Atlanta, Ga., February 1941. Author: Assistant agricultural engineer, Tennessee Valley Authority.

Presentation of Results of Critical Experiments

By Dr. A. E. Brandt

WHILE a student in agricultural engineering before World War I, I took a course in surveying under one of the professors in the civil engineering department of the school I attended. Our manual was the one by Pence and Ketchum which is familiar to so many of you. Having had some surveying experience on construction jobs before entering college, I kept looking further in the book for something new and challenging. Chapter IX, Errors of Surveying, caught my fancy. In the second paragraph, the theory of least squares is mentioned. I asked the professor about this theory and was told with some force that it was a part of higher mathematics and in no way essential to the knowledge of an engineer, as his rather large number of years of successful engineering experience proved. He further refused to waste any time on the subject and strongly advised me to leave such unnecessary theories alone if I wished to become a successful practicing engineer.

Feeling that most of the heat of his discussion and perhaps a part of his attitude were due to his lack of knowledge, I delved into the subject of error to some extent. The professor was right in one respect, I am not a practicing engineer.

I shall quote the first two paragraphs of the chapter that prevented me from becoming a practicing engineer, or at least made me conscious of the errors of observations of natural phenomena, that is, Chapter IX in the 1915 edition of the Pence and Ketchum Surveying Manual: "Errors of observations are of three kinds, viz., (1) mistakes; (2) systematic errors; (3) accidental errors. Systematic errors include all errors for which corrections can be made, as erroneous length of standard, errors of adjustment, refraction, etc. Accidental errors are those which still remain after mistakes and systematic errors have been eliminated from the results.

"It has been found from experience that accidental errors are not distributed at random but follow mathematical laws. These laws are fundamental in the Theory of Least Squares and are: (1) Small errors are more frequent than large ones; (2) positive and negative errors are equally numerous; (3) very large errors do not occur."

The use of the word "random" in the second paragraph is unfortunate since, in modern statistical theory, errors of the third kind mentioned in the first paragraph are known as chance or random errors and the laws given are sometimes called, as a group, the law of errors of random sampling, or, more simply, the law of errors. This use of the word "error" has led to some heated denials by engineers when I have spoken of the errors of their observations. They were positive that such great care had been taken that the observations were without error. They might have been correct with regard to the first two kinds of error, but almost certainly not with regard to the third.

The reaction of some engineers to the facts with regard to observations is this: How can any valid research be done if one cannot secure measurements or other observations without error? The answer is, of course, quite simple and straightforward, namely, take all possible precautions to eliminate mistakes and systematic errors, employ enough replicates to reduce the chance or random errors as much as is required or is consistent with the time and money that may be available for the study being made, and use the variation among these replicates in the analysis of results. The fact that the accuracy with which the value of an angle can be measured may be increased by taking repeated readings is sometimes used without regard to the conditions under which it is true. In fact, one frequently hears a research worker who has only recently embraced the statistical approach, say that one need not be as careful with the individual observations if enough are taken and the results are analyzed statistically.

According to the title, this paper is supposed to be about the presentation of results of critical experiments. A critical experiment is one so designed that it will yield not only the differences between plots or individuals treated differently, but also an estimate of the expected difference between those treated alike, by which the significance of the former may be judged. The observed results of a critical experiment, especially if it be a complex experiment, are not very intelligible to a person not trained in modern statistics, and, I must confess, the statistical analysis by means of which the results are presented all too frequently gives slight aid in making them clear.

As an example of a complex critical experiment, I have selected a potato experiment given by Dr. F. Yates in the Imperial Bureau of Soil Science Technical Communication No. 35, "The Design and Analysis of Factorial Experiments." The effects upon the yield of potatoes of nitrogen, potash, and barnyard manure alone and in combination were studied by combining two levels of each of three materials as follows: sulphate of ammonia, none, and 50.4 lb of N_2 per acre; sulphate of potash, none, and 125.44 lb of K_2O per acre; and barnyard manure, none, and 8.96 tons per acre. The eight treatments and convenient symbols for indicating them are:

- *(1)* — no treatment, none of all three
- *n* — 50.4 lb of N_2 per acre
- *k* — 125.44 lb of K_2O per acre
- *nk* — 50.42 lb of N_2 and 125.44 lb of K_2O per acre
- *m* — 8.96 tons of manure per acre
- *nm* — 50.4 lb of N_2 and 8.96 tons of manure per acre
- *km* — 125.44 lb of K_2O and 8.96 tons of manure per acre
- *nkm* — 50.4 lb of N_2, 125.44 lb of K_2O, and 8.96 tons of manure per acre.

In this experiment, four replicates of each treatment were laid out in four blocks of eight 1/60-acre plots each. A scheme of randomization was used to assign plots to the eight treatments in each block. The treatments, plot yields, and totals are given in Table 1.

Presented before the Power and Machinery Division at the annual meeting of the American Society of Agricultural Engineers at Knoxville, Tenn., June 1941. Author: Chief, conservation experiment stations division, soil conservation research, Soil Conservation Service, U. S. Department of Agriculture.

TABLE 1. YIELD OF POTATOES IN POUNDS

	Block I	Block II	Block III	Block IV	Treatment Totals
(1)	101	106	87	131	425
n	106	89	128	103	426
k	265	272	279	302	1118
nk	291	306	334	272	1203
m	312	324	323	324	1283
nm	373	338	324	361	1396
km	398	407	423	445	1673
nkm	450	449	471	437	1807
Block totals	2296	2291	2369	2375	9331

Often the above table and an analysis of variance as given in Table 2 constitute the entire presentation of the results of such an experiment. This is inadequate for most readers. The yields should be converted to commonly used agricultural units, and the results should be presented in such a way as to make clear the main features of the experiment. As stated above, this experiment was designed to study the effects of nitrogen, potash, and barnyard manure alone and in combination. The results should be presented so as to show these effects or at least the most important ones.

TABLE 2. SUMMARY OF ANALYSIS OF VARIANCE

	D/F	Sums of squares	Mean squares
Block	3	774.1	
N	1	3465.3	3465.3*
K	1	161170.0	161170.0*
NK	1	344.5	344.5
M	1	278817.8	278817.8*
NM	1	810.0	810.0
KM	1	13986.3	13986.3*
NKM	1	124.0	124.0
Error	21	7287.6	347.0
Total	31	466779.6	

*Denotes highly significant result.

Since I come from Iowa where the yield of potatoes is usually given in bushels per acre, I shall use that unit in presenting these results. If the treatment totals in the last column of Table 1 be divided by 4 to give the yields per plot in pounds, then multiplied by 60 to give the yields per acre in pounds, and finally divided by 60, the yields in bushels per acre will result. The factor 60 in the numerator will cancel that in the denominator, so that the treatment totals can be changed to yields in bushels per acre simply by dividing by 4. The eight treatments and the corresponding yields in bushels per acre are given in Table 3.

TABLE 3. AVERAGE YIELDS IN BUSHELS PER ACRE

Treatment	Yield, bu per acre	Treatment	Yield, bu per acre
(1)	106.2	*m*	320.8
n	106.5	*nm*	349.0
k	279.5	*km*	418.2
nk	300.8	*nkm*	451.8

The eight mean yields in Table 3 can be combined in various ways to evaluate the chief features for which the experiment was designed. The mean response to manure may be found from these values in a number of different ways, but an illuminating one is that of separating out the four relevant comparisons in Table 3 thus:

Response to manure:

n and *k* absent	$m-(1)$	=	214.6
n absent, *k* present	$km-k$	=	138.7
n present, *k* absent	$nm-n$	=	242.5
n and *k* present	$nkm-nk$	=	151.0
			4)746.8
Mean response to manure (M)		=	186.7

These responses are sufficiently large and consistent to indicate that they are significant, that is, the chance errors or fluctuations of which we spoke in the beginning, would not be expected to be as large and consistent as these apparent responses.

In a similar way we determine from the same eight mean yields the

Response to potash:

n and *m* absent	$k-(1)$	=	173.3
n absent, *m* present	$km-m$	=	97.4
n present, *m* absent	$kn-n$	=	194.3
n and *m* present	$knm-nm$	=	102.8
			4)567.8
Mean response to potash (K)		=	142.0

and the

Response to nitrogen:

m and *k* absent	$n-(1)$	=	0.3
m absent, *k* present	$nk-k$	=	21.3
m present, *k* absent	$nm-m$	=	28.2
m and *k* present	$nkm-nm$	=	33.6
			4) 83.4
Mean response to nitrogen (N)		=	20.8

These results indicate a substantial response to potash and a small response to nitrogen.

Upon examining the four comparisons or responses to manure, we find that the two responses to manure with potash absent are considerably larger than the two with potash present. This failure of the effect of manure to be the same in the presence as in the absence of potash is identical with the failure of the effect of potash to be the same in the presence as in the absence of manure and is known as the interaction between the two factors manure and potash. This interaction may be evaluated as follows:

Interaction between *m* and *k*:

n absent	$[mk+(1)]-[m+k]$	=	−75.9
n present	$(nmk+n)-(nm+nk)$	=	−91.5
			4)−167.4
Mean (MK)		=	−41.8

By analogy with the main effects, this interaction appears to be large enough to indicate that the effects of manure and potash were not additive when applied together.

With the three factors, there are two other interactions involving two factors each. They are:

Interaction between *m* and *n*:

k absent	$[nm+(1)]-[n+m]$	=	27.9
k present	$(nmk+k)-(nk+mk)$	=	12.3
			4)40.2
Mean (MN)		=	10.0

and

Interaction between *n* and *k*:

m absent	$[nk+(1)]-(n+k)$	=	21.0
m present	$(nkm+m)-(nm+km)$	=	5.4
			4)26.4
Mean (NK)		=	6.6

Neither interaction involving nitrogen appears to be significant.

The interaction involving all three of the factors, sometimes called the second order interaction, may be evaluated as follows:

Interaction involving n, m, and k

$$[n+m+k+nmk] - [nm+nk+mk+(1)] = -15.6$$

$$4)\overline{-15.6}$$

$$\text{Mean } (NMK) = -3.9$$

This interaction is almost certainly too small to be significant. Higher order interactions are difficult to interpret.

These main effects and interactions are summarized in Table 4.

TABLE 4. MAIN EFFECTS AND INTERACTIONS

Effects and interactions	Response in bu per acre
M	186.07
K	142.0
N	20.8
MK	–41.0
MN	10.0
NK	6.6
MNK	–3.9

These values all have the same standard error, since they are each one-quarter of an algebraic sum involving all eight treatment combinations. The estimate of this standard error (21 degrees of freedom) is calculated from the error term in the analysis of variance in Table 2 as follows:

$$\text{Standard error} = [\pm\sqrt{(32)(347.0)}]\left[\frac{60}{(60)(16)}\right]$$

$$= \pm 105.4/16$$

$$= 6.59 \text{ bu per acre}$$

Any value in Table 4 that exceeds 13.18 bu per acre (twice the standard error) may be judged significant. Thus *M*, *K*, *N*, and *MK* are significant as we previously were led to believe by the size and consistent behavior of the various components of these responses. These conclusions are, of course, identical with those shown in Table 2.

A measurement, such as length, volume, and weight, which may take any of an infinite series of values, is called a continuous variate or a continuous variable. Its exact value would require an infinite number of decimal places and is therefore impossible. This holds true even if the exact value is an integer or zero. Recently, in one of our manuscripts, the editor used his red pencil right lustily on some tables. Entries such as 0.47 had the zero deleted, whereas 0.00 had the two zeros after the decimal point deleted. Having taught school for a number of years, I favor placing the zero before the decimal point for numbers less than one, but in the face of editorial policy I agreed to deleting it since it is not a significant figure in numbers such as 0.47. The zeros following the decimal point in 0.00 are significant, however, since the measurement was not zero but was less than .005.

Many research workers apparently have the idea that the accuracy of a number is proportional to the number of places recorded. Any recorded measurement is not an exact value but a conventional representation of a range within which the exact value is expected to lie. If, as expected, the exact value does lie within the indicated range, the measurement is accurate independent of the number of places recorded. By increasing the number of places recorded, that is, by reducing the range within which the true value lies, the refinement or precision of a measurement can be increased. The value of Π has been determined to something over 700 places, yet 3, 3.1, 3.14, 3.142, and 3.1416 are all accurate because the true value of Π so far as it has been worked out does lie within the ranges indicated. The limits implied by the above values are 2.5 to 3.5, 3.05 to 3.15, 3.135 to 3.145, 3.1415 to 3.1425, and 3.14155 to 3.14165, respectively. The respective ranges implied are 1, .1, .01, .001, and .0001 which indicate the increase in precision due to increasing the number of places recorded.

The yields of potatoes for the experiment reported by Dr. Yates were recorded to two places of decimals. For the purpose of this analysis they were rounded to the nearest pound. No loss of accuracy resulted, of course, though the refinement of the results is less than that of the original observations. That this has not resulted in the loss of pertinent information is evident from the size of the standard error.

On page 451 of the May 9 issue of "Science" is a discussion by Duff A. Abrams of a recent bulletin, "Thermal Properties of Concrete." The entire discussion, which covers less than a page, is well worth reading, but part of it is of such general application that it is quoted for your consideration:

"A notable feature is the failure to recognize the limitations of experimental data. The Bureau scientists apparently missed two important principles: (1) That the results of arithmetical operations are never more precise than the least precise value which enters into the computation; (2) that an experimental value can not be more precise than the least precise data on which it is based. Item (2) is, of course, only an application of (1).

"Under 'Computations of Conductivity' (p. 110) 15 two-place and 19 three-place factors are introduced in dealing with the fundamental data. Needless to say, it is absurd to compute values from these data to 4, 5, or 6 significant figures, as was done by the authors.

"Conversion factors, to be used with the two or three-place data, are given to eight significant figures; for example, the factor 0.256,065,03 is given (p. 41) for converting diffusivity values from English to metric units.

"In spite of the appearance of great refinement, these four, five, and six-place computed quantities are only two-place values. These computed values wear the cloth but not the clothes of accuracy. The methods of this Bulletin are analogous to measuring with one's thumb, then computing the length to the nearest ten-thousandth of an inch."

A Summary of Barn Hay Curing

(Continued from page 292)

1-in boards on 2x6-in stringers, was constructed on top of the mow floor. This duct system was built in sections to facilitate removal for storage of farm implements after the hay has been fed out.

The average size installation in the Tennessee Valley covers a mow floor area of approximately 1500 sq ft, using blowers or fans delivering air at approximately 12,000 cfm. No auxiliary heat is being used.

In addition to the 13 farm installations, experimental systems are in operation at University of Tennessee, Knoxville; University of Illinois, Urbana; University of Georgia, Athens; and Virginia Polytechnic Institute, Blacksburg. The Tennessee studies began in 1935, Georgia studies in 1939, Illinois studies in 1937, and Virginia studies in 1940. Investigations in the latter three states are concerned chiefly with the adaptation of the barn-curing system to the climatic and operating conditions in these states.

During the 1940 season approximately 748 tons of hay were cured in barn-type curing systems known to be in operation in the country at an average power consumption of 39 kwhr per ton.

Dehydration of Sweet Potatoes for Livestock Feed

By Arthur B. Kennerly

THE CULL sweet potato can now take its place among the valuable by-products of a chemurgic agriculture. Strangely enough this accomplishment is the result of a deficiency in corn yields rather than a primary recognition of the merits of the feeding value of dehydrated sweet potatoes.

With the establishment of a starch plant to make starch from sweet potatoes at Laurel, Miss., came an added interest in sweet potatoes and their potential uses.

Perhaps the most important problem to be overcome was a method for retaining the valuable pro-vitamin A during the drying process. This vitamin aids in the prevention of infections and has a marked influence in the reproduction of livestock. It was found that if lime is used as a dehydrating agent, most of the vitamin A would be lost, but experiments with sulphur dioxide as a dehydrating agent have given good results in retaining this vitamin. Its presence in the dried sweet potato meal is indicated by tests conducted at College Station, Texas, which revealed that butter made from the milk of cows fed sweet potato meal was a deeper yellow color than the butter produced from cows in the same test fed yellow corn.

Briefly, the steps in dehydrating the sweet potato for livestock feed are (1) the potatoes are washed in flumes, (2) from the flume they are dropped into a grinder, (3) the ground material is then treated with sulphur dioxide to prevent oxidation of vitamin A, (4) small amounts of the dried meal are mixed with the wet material which hastens drying process, and (5) the material is run through drier at about 55 C (degrees Centigrade), where it is dried to about 10 per cent or less moisture content, after which it will not absorb moisture from the air in storage.

The washing flume is a spray rotary washer, with the potatoes being fed directly into the washer, or carried to it from the storage bin by means of a flume of water. If the potatoes have been grown in sandy land the washing process is a simple one.

Two methods of grinding the potatoes were tried in the laboratories at the North Texas State Teachers College. It was found that the standard meat grinder would do the job, and this type of grinder was used for the most part. Further experimentation, however, showed that a saw-tooth rasp grinder would do satisfactory work. Fourteen 6-in and twelve 7-in saw blades were placed side by side on a shaft mounted in a housing to form the hopper. This machine gave a grinding length of about 3 in, with variations in size of ground material from a long shred to a finely pulverized component.

One ton of potatoes requires about 2 lb of sulphur to make the sulphur dioxide gas necessary to chemically treat the ground product, the gas being liberated by burning the sulphur.

The drying unit must have well-controlled heating. After taking from the final dehydration product an amount sufficient to mix back with the ground potato to absorb excess moisture, the mixture is run into a rotating drum hot-air unit. The drier ranges in temperature from 80 to 100 C, though the product itself seldom exceeds 55 C.

Repeated tests at various state experiment stations show that the feeding value of dried sweet potato meal is equivalent to that of yellow corn. The Texas station tests show it to have 91 per cent of the feeding value of yellow corn, but tests from other states indicate higher values, which tend to equalize their comparative values.

When it is realized that an acre of sweet potatoes yielding 150 bu will turn out 45 bu of dehydrated sweet potato meal, the tremendous possibilities of this dehydrating process can be conceived. In other words, land which normally produces 15 bu of corn per acre will produce 45 bu of sweet potato meal. Cheap protein in cottonseed meal, cheap carbohydrates in dried sweet potato meal, and long grazing periods in improved pastures offers a good field for dairying and raising beef cattle in the South.

There are two possibilities by which farmers may obtain the dehydrated feed. One is by the establishment of commercial plants in sweet potato centers. A farmer hauling his potatoes to such a plant would receive \$5 per ton and would pay \$30 per ton for the dried product. In terms of pounds, the farmer would haul 2,000 lb of potatoes to the plant and would carry home 333 lb of dried meal. The total available meal from 2,000 lb of potatoes is 600 lb, or 30 per cent of the original weight of potatoes.

Furthermore, in terms of bushels for comparing with corn, sweet potato meal at \$30 per ton would be equivalent to corn at 84 cents per bushel. It is doubtful if much sale for the product could be found in periods when corn was selling for less than 84 cents per bushel, and it is also doubtful if farmers would be interested in hauling even their cull potatoes to a plant where they would receive no more than 14 cents per bushel, especially in cases where it was necessary to haul long distances.

The other possibility for obtaining dried sweet potato meal, and one which probably offers more promise to the farmer, is the establishment of small community drying plants cooperatively owned. By this plan the farmers owning stock in the plant and having potatoes to be dried would provide their own labor and could possibly provide fuel from the woods. The advantage of this setup would be the low operating cost. As an example, a grower hauling 2,000 lb of potatoes to this type plant would haul back to his farm about 500 lb of the meal, leaving 100 lb at the plant as toll. This is equivalent to 37 bu of the finished product per acre, where the yield amounts to 150 bu per acre. With corn selling at 60 cents per bushel, this would be equivalent to an income of \$22.20 per acre.

It is not anticipated that No. 1 potatoes be used for drying purposes. They would be turned into the usual channels for food purposes. Use of the lower grades of potatoes, however, would return good profits through feeding to livestock and would have the additional value of taking such grades out of competition with the best potatoes. Furthermore, the yields used are low. It is common practice to obtain as high as 300 bu of sweet potatoes per acre; a yield equivalent to 75 bu per acre after the potatoes have been processed.

The problem of dehydrating sweet potatoes deserves the best thinking on the part of agricultural engineers. Factors which must be studied are the best type of grinder or cutter, size and design of drier, the most economic fuel, and the arrangement of the whole to provide an efficient operating plant. The chemists have blazed the trail; agricultural engineers must complete the task.

A paper presented before a meeting of the Southwest Section of the American Society of Agricultural Engineers at Dallas, Tex., April 1941. Author: Farm management specialist, Farm Security Administration, U. S. Department of Agriculture.

NEWS

Program of the North Atlantic Section Meeting

THE NORTH Atlantic Section of the American Society of Agricultural Engineers will hold its usual yearly meeting this year at the State 4-H Camp at Jackson's Mill, West Virginia, September 29 to October 1. The program arrangements are in charge of Section Chairman Frank H. Hamlin, vice-president of Papec Machine Co.

The first session will be held Monday forenoon, September 29, with Geo. W. Kable, president of A.S.A.E., and editor of "Electricity on the Farm," presiding. C. H. Hartley, state 4-H club leader, will welcome the Section to West Virginia, to which a response will be made by Section Chairman Hamlin. H. E. Babcock, a farmer and the founding genius of the country's largest farmer-controlled business (G.L.F.), as well as chairman of the board of trustees of Cornell University, will address the meeting on "What's Ahead for Farmers in the North Atlantic Region." Ben Hibbs, editor of "Country Gentleman" will talk on the subject "What Farmers Want to Know." A biochemist's view of engineering in agriculture will be presented by Dr. Chas. F. Rogers of the Ohio Agricultural Experiment Station, a discussion of which will be led by H. H. Tucker, manager, Educational and Research Bureau for By-Products Ammonia.

The Monday afternoon session will be presided over by W. T. Ackerman of New Hampshire, with the following program attractions: "What Farmers Are Doing for Themselves," by W. G. Wysor, general manager of the Southern States Co-operative; "The Economic Possibilities of Agricultural Engineering," by Dr. R. B. Corbett, an economist and director of the Maryland Agricultural Experiment Station, and formerly dean and coordinator of the University of Connecticut; "Good Patents and How They May be Obtained," by R. G. Ferris, research engineer of Starline, Inc., and "Weak Links in the Efficiency of Present Farm Operating Methods," a speaker for which will be announced later.

Monday evening will be devoted to four concurrent round tables: (1) Power and Machinery, with V. S. Peterson, Pennsylvania State College, presiding; (2) Rural Electrification, with Jos. S. Webb, Philadelphia Electric Co., presiding; Farm Structures, with W. C. Krueger, Rutgers University, presiding; and (4) Soil and Water Conservation, with Dr. A. E. Brandt, U. S. Soil Conservation Service, presiding.

The forenoon session on Tuesday, September 30, will be presided over by A. A. Stone, professor of rural engineering, New York State Institute of Applied Agriculture. Oliver Shurtleff, dean of instruction, Fairmont State Teachers College, West Virginia, will talk to the subject "Burn the Bushel," discussing important teaching and extension problems in agricultural engineering. "Uncle Sam's Big Building Job" will be discussed jointly by Ray W. Carpenter and A. V. Krewatch of the agricultural engineering staff at the University of Maryland. Newton O. Belt of the engineering department of E. I. du Pont de Nemours & Co., will discuss "Doing Something About the Weather," from an engineering and scientific standpoint.

The Tuesday afternoon session will be in the capable hands of John R. Haswell, professor of agricultural engineering extension, Pennsylvania State College, who will preside. A joint paper by H. S. Pringle and E. S. Shepardson of the agricultural engineering staff at Cornell University will present the subject "The New Method of Teaching Care and Repair of Electrical Equipment." Walter H. Pomerene of the U. S. Soil Conservation Service will present a paper, entitled "Grass Saves Soil." Another paper on this program is "New Machinery Developments—Promising and Otherwise," a speaker for which is yet to be announced. This session will also include an explanation and demonstration of the Parks moisture tester by its inventor, Robert Q. Parks, agronomist of the Ohio Agricultural Experiment Station. The session will be closed by the usual business meeting of the Section.

The North Atlantic Section annual dinner will take place Tuesday evening, September 30, over which no less a personage than L. F. Livingston, manager of Du Pont's agricultural extension division, will preside as toastmaster. Geo. E. Mullin, Jr., of General Electric Company has been given the responsibility of "funmaster" for this occasion, and there will also be a "songmaster" yet to be announced, which is sufficient to insure that this event will be a howling success. The one and only address for the occasion is entitled "A 'Flash-Over' from the Presidential Kable," by Geo. W. Kable, president of A.S.A.E.

A field trip of interest to agricultural engineers is being arranged for the forenoon of Wednesday, October 1, and all those who attend the meeting will be welcome to attend the 12th Annual Mountain State Forest Festival at Elkins, West Virginia, fifty miles from Jackson's Mill, which will take place October 2, 3, and 4.

A special program for the ladies who attend the North Atlantic Section meeting is being arranged.

* * * * *

The State 4-H Camp at Jackson's Mill, W. Va., where the North Atlantic Section meeting is to be held, is located on route US 19, 4 miles north of Weston and 19 miles south of Clarksburg. US 50, the usual route out of Washington, D. C., passes through Clarksburg, and to reach Jackson's Mill, turn south on US 19 at Clarksburg. From the north US 19 or US 119 may be used, the latter being preferable. For those taking US 50 from the east, an alternate route with much less travel is suggested: Turn left on US 220 7 miles west of Romney, W. Va., and follow this to Petersburg (32 miles); turn right on WVa 4 and follow 22 miles to Seneca Rock; turn right on US 33 and follow to Weston (86 miles). This route is on easy grades over the mountains and the mileage is about the same as via Clarksburg. A.S.A.E. signs at Weston will direct travelers to Jackson's Mill. For those attending the meeting by private plane, there is a landing field at Jackson's Mill. Those arriving on regular air routes from the north and east will be met at Elkins or Clarksburg municipal airports, if they will advise local committee of time of arrival. Elkins airport is approximately 55 miles and Clarksburg 23 miles from Jackson's Mill.

There are 13 cottages at the State 4-H Camp besides numerous other buildings, and if those attending are bringing their families, they should advise the local committee beforehand so that space may be provided. Rate for meals at the camp is 50 cents; lodging, 51 cents. For those who desire hotel accommodations, they may be obtained in Weston or Clarksburg.

The mail address at the State 4-H Camp is RR 5, c/o Jackson's Mill, Weston, W. Va. The telegraph office is located at Weston, and the telephone number of the Camp is Weston 1080.

A.S.A.E. Meetings Calendar

Sept. 29 - Oct. 1—North Atlantic Section, Jackson's Mill, W. Va.

December 1 - 3—Fall Meeting, Stevens Hotel, Chicago.

June 22 - 25—Annual Meeting, Hotel Schroeder, Milwaukee.

New REA Training Class

A NEW training class consisting of 33 graduates from state colleges and universities in all parts of the country reported June 16 for a year's training with the Rural Electrification Administration in Washington. The group included 24 electrical engineers, 8 agricultural engineers, and 1 mechanical engineer, all of whom came from schools in 20 states. It was the sixth group of the kind to be brought together for training by the REA. Earlier trained groups have furnished valuable members of the staff of this agency, who now occupy many responsible positions in its technical divisions.

During the year of the training programs, by actual experience in the work of the operating divisions, these young engineers will obtain a well-rounded conception of the whole program. The experience thus gained will be supplemented by a series of seminars conducted by leading officials of the Department of Agriculture and the REA, by weekly evening meetings at which problems relating to the rural-electrification program are presented and discussed, and by visit to significant power and other related establishments. Toward the end of the training period they are given field assignments. After the year's training, most of these engineers will be assigned to permanent duty with the various operating divisions where their abilities can best be utilized.

This year's group of trainees will have the opportunity to work and associate with a group of eight young engineers from eight Central and South American republics who are arriving to spend a year studying the techniques and methods of the REA.

A.S.A.E. Annual Meeting Resolutions

DURING the annual business meeting of the American Society of Agricultural Engineers held in conjunction with its 34th annual meeting at Knoxville, Tennessee, June 23 to 26, certain resolutions were presented and adopted which will not only be of interest to members of the Society who did not attend the meeting, but will also be of general interest as indicating the Society's position on questions of public interest. Following is the report of the Resolutions Committee — W. W. Weir (chairman), F. R. Jones, and B. B. Robb — as amended and adopted during the meeting:

Whereas loss of life has resulted from improper designs and installations of electric fencing equipment, and

Whereas the National Bureau of Standards, the Underwriters' Laboratories, and several states have codes or standards for electric fence equipment which, so far as known, are safe, and

Whereas a number of farmers, unmindful of the danger, are using various types of unapproved systems, which are believed to hazard human life, therefore be it

Resolved that the American Society of Agricultural Engineers urge that greater efforts be made by the various interested agencies to further warn the public of the dangers involved in the use of such unapproved electric fence devices and installations, and that the Secretary of the Society be instructed to send copies of this resolution to the proper agencies of public regulation in each state.

* * * * * * * * * *

Whereas food and other agricultural products are essential parts of the national defense program, and

Whereas if our requirements are to be met, it is essential that adequate farm machinery and equipment be provided and kept in operating condition to accomplish this, including the necessary repair parts, and

Whereas if this is to be done, priorities must be arranged so that necessary materials for repair parts and essential machinery can be secured as needed, and

Whereas shortage of skilled mechanics and other farm help for repairing farm machinery are beginning to appear in some localities, and

Whereas consideration should be given to deferment from military service of a nucleus of trained men, and to taking immediate steps to train new workers and to further instruct farmers how to make repairs, and

Whereas the facilities of the vocational high schools and agricultural colleges for training workers and farmers should be utilized to the fullest extent, be it therefore

Resolved that the American Society of Agricultural Engineers, recognizing the many complex problems confronting industry and government, urge that early and adequate attention be given to the problems concerning farm operating equipment and offer its services in any capacity where it can be useful, and be it further

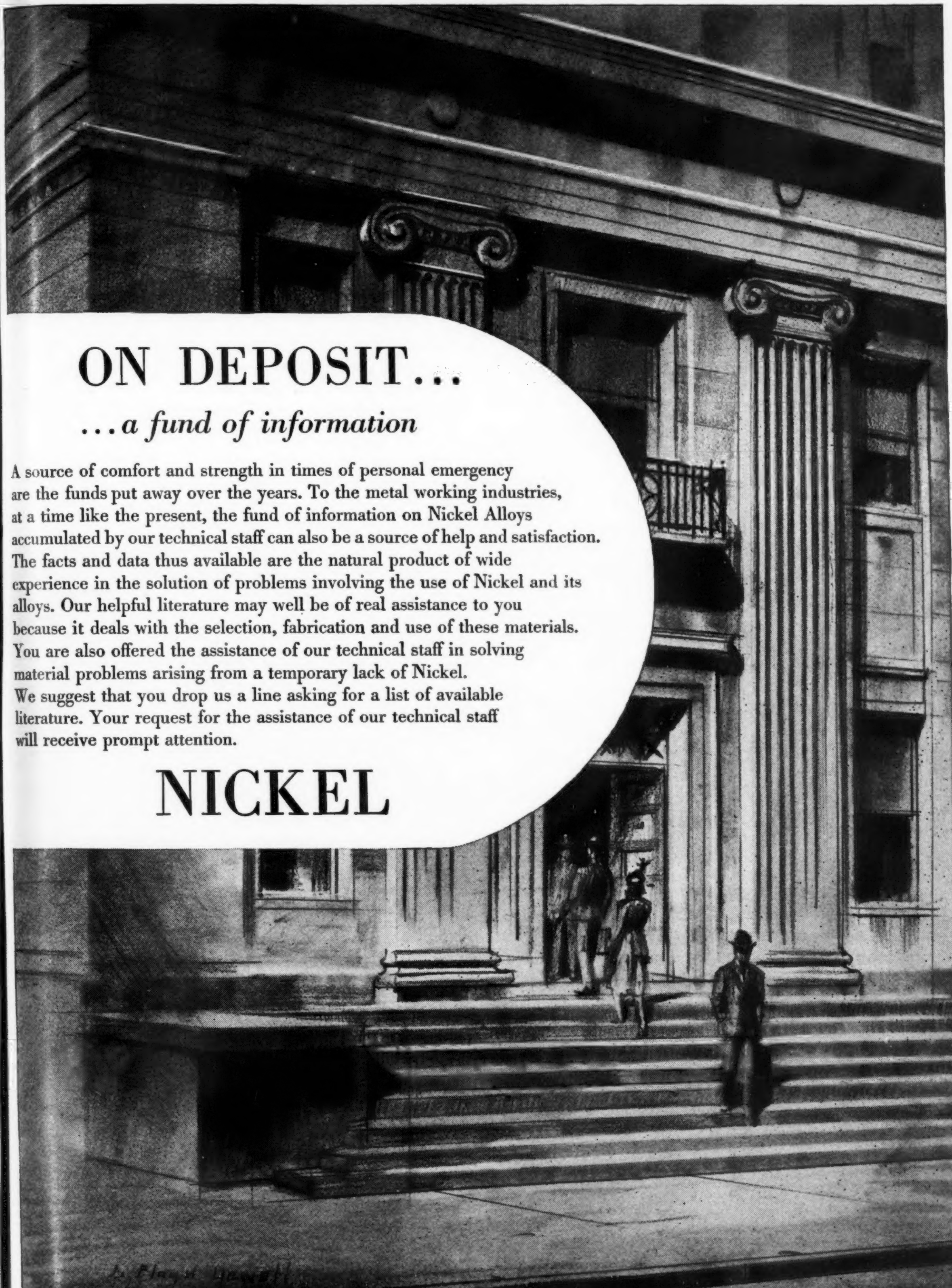
Resolved that the Secretary of the Society be instructed to send copies of this resolution to the Office of Priorities and Civilian Supply and to the Secretary of Agriculture.

* * * * * * * * * *

(Continued on page 300)

HIGHSPOTS OF THE A.S.A.E. 1941 ANNUAL DINNER

These four views show some of the highspots of the annual dinner of the American Society of Agricultural Engineers at its 34th annual meeting at Knoxville, Tenn., in June. (Upper left) President E. E. Brackett awards the John Deere Gold Medal to R. W. Trullinger, assistant chief, Office of Experiment Stations, U. S. Department of Agriculture. (Upper right) The award of the Cyrus Hall McCormick Gold Medal to H. C. Merritt, vice-president, Allis-Chalmers Mfg. Co. (Lower left) Julius E. Purvine, a member and representative of the A.S.A.E. Student Branch at Oregon State College, receives from President Brackett the Farm Equipment Institute trophy which the Society awarded the Branch for outstanding student branch activity during the school year 1940-41. (Lower right) As the final act of his office President Brackett hands the incoming president, Geo. W. Kable, a gavel which he had had made from osage orange wood from the old Freeman homestead in Gage County, Nebraska, the first free homestead in the United States ever taken out under the Free Homestead Act of 1863 signed by President Lincoln



A.S.A.E. Annual Meeting Resolutions

(Continued from page 298)

Whereas our nation is now more or less involved in a world-wide conflict which may affect the preservation and future stability of the government, therefore be it

Resolved that the American Society of Agricultural Engineers pledge its whole-hearted and unanimous support and cooperation to any program or activity which may in any way assist in the furtherance of the national defense program and preservation of the nation and its democratic form of government.

* * * * * * * * *

Whereas we, the members of the American Society of Agricultural Engineers, assembled for our thirty-fourth annual meeting this week at the University of Tennessee, Knoxville, Tennessee, have had the pleasure of attending one of the most enjoyable, interesting, and profitable meetings in the history of the Society, and

Whereas it is our desire to make known and to publicly express our appreciation to all those who have shared in the effort and responsibility of making this delightful occasion possible, now therefore be it

Resolved that we express our sincere appreciation to the University of Tennessee, the Tennessee Valley Authority, the Society's committee on local arrangements, the Knoxville Chamber of Commerce, the National Park Service, and the numerous individuals and organizations who have cooperated with them, for our pleasure and comfort, and for their efficient handling of the many details of this meeting, and be it further

Resolved that we express to the Meetings Committee and to the several speakers our appreciation for an excellent program, and be it further

Resolved that the Secretary of the Society be instructed to transmit a copy of these resolutions to all and sundry who have contributed so generously and labored so tirelessly to the success of this annual meeting.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the July issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

C. Glynn Blackwell, junior agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Eutaw, Ala.

Harold C. Campbell, U. S. Army Air Corps. (Mail) Garden City, S. D.

Thomas E. Cowan, junior agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Box 44, Balmorhea, Tex.

George W. French, junior agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) SCS-AK-10, Forest City, Ark.

Melvin J. Happe, engineering assistant, tractor division, Allis-Chalmers Mfg. Co. (Mail) 1357 W. Wisconsin Ave., Milwaukee, Wis.

James W. Harwell, junior soil conservationist, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 565 Boulevard, Athens, Ga.

Burdette C. Hinsey, assistant agricultural aide, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Houston, Minn.

James M. Martin, research engineer, Massey-Harris Co., Racine, Wis. (Mail) R.R. No. 3, Box 181.

John F. Mitchell, junior agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Box 193, Murfreesboro, Tenn.

George R. Mowry, junior engineering trainee, Rural Electrification Administration, U. S. Department of Agriculture, Washington, D. C. (Mail) 1727 P Street.

Gwilym F. Prideaux, lighting engineer, General Electric Co., Nela Park, Cleveland, Ohio.

Arnold B. Skromme, engineer, Firestone Tire and Rubber Co., Akron, Ohio.

Harold G. Talbot, 2nd lieut., U. S. Army. (Mail) Box 527, Big Springs, Tex.

A.S.A.E. Organization — 1941-42

OFFICERS AND COUNCIL

Geo. W. Kable - - - - - - - - *President*
E. E. Brackett - - - - - - - *Past-President*
K. J. T. Ekblaw - - - - - - *Past-President*
C. E. Frudden - - - - - - - *Councilor*
R. W. Carpenter - - - - - - *Councilor*
E. A. Silver - - - - - - - *Councilor*
E. G. McKibben - - - - - - *Councilor*
R. H. Driftmier - - - - - - *Councilor*
B. D. Moses - - - - - - - *Councilor*
Raymond Olney - *Secretary-Treasurer*
(St. Joseph, Michigan)

Nominating Committee — R. U. Blasingame (chairman), T. E. Hienton, H. H. Sunderlin

A.S.A.E. Representatives on Other Organizations

National Fire Waste Council (Sponsored by U. S. Chamber of Commerce) — Henry Giese, W. G. Kaiser, J. F. Schaffhausen

National Fire Protection Association — Henry Giese, W. G. Kaiser, J. F. Schaffhausen

American Society for Testing Materials —
(1) *Representative-at-large* — K. J. T. Ekblaw
(2) *Committee A-5* (Corrosion of Iron and Steel) — B. A. Jennings

Advisory Council to Federal Board of Surveys and Maps (U. S. Department of the Interior) — John R. Haswell

Joint Committee on Fertilizer Application (American Society of Agronomy, American Society of Horticultural Science, National Fertilizer Association, Farm Equipment Institute, and A.S.A.E. cooperating) — G. A. Cumings (chairman), C. J. Allen, H. P. Smith, C. H. White, G. B. Nutt, W. L. Zink, C. H. Zirckel, G. W. Giles, G. D. Jones, J. A. Slipher, J. P. Fairbank, R. W. Trullinger

Joint Committee on Hydrology (Section of Hydrology, American Geophysical Union and A.S.A.E. cooperating) — H. S. Riesbol, F. E. Staebner, R. Earl Storie

Joint Committee on Measurement of Soil Tilth (American Society of Agronomy and A.S.A.E. cooperating) — I. F. Reed, M. L. Nichols, G. D. Jones, B. A. Jennings

Joint Committee on Refrigeration of Agricultural Products (American Society of Refrigeration Engineers and A.S.A.E. cooperating) — J. E. Nicholas, R. L. Perry, P. T. Montfort

Joint Committee on Poultry Housing (Poultry Science Association and A.S.A.E. cooperating) — M. A. R. Kelley, J. L. Strahan, L. L. Sammet, J. C. Wooley

Standing Committees

Meetings Committee — A. W. Turner (chairman), A. J. Schwantes, A. V. Krewatch, G. B. Hanson, H. S. Riesbol, H. E. Pinches

Committee on Local Arrangements for 1942 Annual Meeting — C. E. Frudden (general chairman)

Finance Committee — E. E. Brackett (chairman), S. P. Lyle, G. W. Kable

Jury of Awards of Honor — G. W. McCuen (chairman), L. F. Livingston, R. U. Blasingame, A. P. Yerkes, S. P. Lyle, K. J. T. Ekblaw, E. E. Brackett

Committee on F. E. I. Award — B. G. Van Zee (chairman), H. H. Sunderlin, Wm. E. Meek, Jr.

Committee on Student Branches — F. R. Jones (chairman), L. H. Skromme, D. A. Milligan, D. C. Sprague, Clyde Walker

Committee on Extension — C. N. Hinkle (general chairman)
Public Service Group — R. D. Barden (chairman), G. E. Martin, R. H. Gist, H. S. Pringle, J. P. Fairbank, M. R. Bentley
Private Industry Group — F. J. Zink (chairman), R. E. Hayman, G. C. Bartells, D. H. Malcom, G. E. Mullin, Jr., J. D. Long

Committee on Research — W. D. Ellison (chairman), E. A. Silver, F. A. Brooks, G. D. Jones, C. J. Hurd, R. W. Trullinger, R. M. Merrill, J. A. Scholten, S. A. Witzel, M. L. Nichols

Special Committees

Committee on Industrial Uses of Agricultural Products — A. P. Yerkes (chairman), H. T. Herrick, Wheeler McMillen, Harry Miller, L. F. Livingston

Committee on Farm Appraisal — F. H. Schreiner (chairman)

Committee on Farm Safety — V. S. Peterson (chairman)

Agricultural Engineering Digest

A review of current literature by R. W. Trullinger, assistant chief, Office of Experiment Stations, U. S. Department of Agriculture. Copies of publications reviewed may be procured only from the publishers at the addresses indicated.

Agricultural Engineering Investigations at the Colorado Station. (Partly coop. U.S.D.A.) Colorado Sta. (Fort Collins) Rpt. 1940, pp. 51, 52-55. High-strength wire for concrete reinforcement and waterproofing of adobe construction have been studied by A. R. Legault; an experimental check of Rohwer evaporation formula has been made by M. Parshall; an apparatus for measuring fall velocity of particles in water has been devised by D. Gunder, together with a method for separation of sand according to fall velocity in water; work on design and invention of irrigation structures has been carried out by R. Parshall; and a study of irrigation use of ground water in the South Platte drainage basin has been started by W. E. Code, together with work on fluctuation of ground-water levels. Design and operation of pumping plants have been studied by C. Rohwer, a photographic method of making snow surveys by M. Parshall et al., and snow course measurements by R. Parshall et al. Single seed ball planting and storage losses in beet piles were also investigated.

Tile Drainage Not Advocated for Land Overlying an Artesian Basin, *W. Gardner*. Farm and Home Sci. (Utah Sta., Logan), 1 (1940), No. 4, p. 5, fig. 1. This is a popular summary of model experiments showing that land overlying an artesian basin can be adequately drained by tile only if the tile lines are laid so deep and so close together as to make the cost prohibitive. Pump wells, making the excess water available for irrigation, are considered to offer a practicable solution of the problem of the drainage of such lands.

Research and Investigational Activities in Agricultural Engineering, *C. E. Seitz*. Va. Engin. Expt. Sta. (Blacksburg) Bul., 34 (1940), No. 3, pp. 58, pl. 1, figs. 20. This bulletin reports upon soil and water conservation, rural electrification, household equipment, farm power and machinery, and farm building investigations.

Temperature of Wheat in Bins of Various Construction, *T. E. Long*. (Coop. U.S.D.A.) North Dakota Sta. (Fargo) Bimo. Bul., 3 (1941), No. 4, pp. 12-16, figs. 4. Bins of 500-bu capacities were used, temperatures were determined at 16 points in each bin, and the following types of construction were included in the test: Plain metal floor and side walls, usual cone-type ventilated roof; 20-gage perforated metal floor and side walls, ordinary metal roof; single wall wood bin, sides of 6-in drop siding, gable roof covered with ordinary roofing material; and double wall bin inside lined with tight-fitting 1x6-in lumber. Average temperatures for each type of bin are graphically shown for each month from October to February 1938-39 and for October, November, and February 1940-41. It is pointed out that the extreme temperatures are quite as important as the average, inasmuch as some insects might survive in the warmer parts of the stored-wheat mass, although temperatures low enough to kill them are reached at other points in the same bin.

Agricultural Engineering Investigations by the Arizona Station. Arizona Sta. (Tucson) Bul. 171 (1941), pp. 180-183, figs. 4. This bulletin reports leveling of land from an average gradient of 2 in per 100 ft to a dead level, with a resultant improvement of penetration by irrigation water such that the crop increases of one or at most two seasons have paid the cost of the leveling; experiments with the traveling hay baler which has brought about a general use of the machine throughout the state; and establishment of the border disk as an implement valuable for the rapid raising of high water-controlling borders and for elimination of weeds by occasional use after bordering.

Literature Received

"Electricity in the Home and on the Farm", by Forrest B. Wright, (Mem. A.S.A.E.), assistant professor of agricultural engineering, Cornell University. Second edition. Cloth, 5⅜x8 in, 372 pages, 293 figures. $2.75. John Wiley & Sons, Inc., New York. In this edition all parts of the book have been thoroughly revised in order to bring the contents up to date and to make the book more teachable, and the material of the first edition has been carefully evaluated in the light of experience of many teachers who use the book. An important addition is the new chapter on wiring systems for the farm and the home. The first part of the book consists of a series of practical jobs arranged in order of difficulty and the second part comprises *(Continued on page 304)*

Literature Received

(Continued from page 302)

eleven chapters of text dealing with the fundamentals of electricity. Chapter headings of part II cover the nature of electricity, electric circuits, electrical terms and measurements, mechanisms, electrical effect, electro-magnetic induction, d-c generators and motors, alternating current, power transmission and distribution systems for alternating current, wiring systems for the farm and the home, and a-c generators and motors.

"FARM BUILDINGS," by Deane G. Carter (Fellow A.S.A.E.), professor of agricultural engineering, University of Arkansas, and the late W. A. Foster, formerly professor of rural architecture, University of Illinois. Third edition (rewritten). Cloth, 6x9 in, 404 pages, 222 figures. $3.75. John Wiley & Sons, Inc., New York. This is primarily a book to present the subject matter of a course in farm buildings for students in colleges of agriculture, although much of the contents is of value also to agricultural workers, teachers, and others interested in farm structures. The third edition has been completely revised and rewritten. A series of problems for further study has been added, and the bibliography includes some of the source material and lists additional references. The chapter headings cover economics and costs of farm building, building materials, structural requirements, the structure of farm buildings, cost and quantity calculations, arrangement and location of buildings, environmental conditions in farm buildings, farm barns, poultry housing, swine housing, silos, grain and hay storage, storage and service buildings, farm housing conditions and needs, farm house planning, kitchens and storage equipment, house construction and remodeling.

EMPLOYMENT BULLETIN

The American Society of Agricultural Engineers conducts an employment service especially for the benefit of its members. Only Society members in good standing may insert notices under "Positions Wanted," or apply for positions under "Positions Open." Both non-members and members seeking to fill positions, for which ASAE members are qualified, are privileged to insert notices under "Positions Open," and to be referred to members listed under "Positions Wanted." Any notice in this bulletin will be inserted once and will thereafter be discontinued, unless additional insertions are requested. There is no charge for notices published in this bulletin. Requests for insertions should be addressed to ASAE, St. Joseph, Michigan.

POSITIONS OPEN

AGRICULTURAL ENGINEER wanted to teach farm power, farm machinery, and farm buildings in an agricultural engineering department of a state college. Position open September 1. Salary $2160 to $2700, depending upon qualifications of the applicant. Semester teaching load about 4 to 5 lectures and 5 two or three-hour laboratory periods per week. Applicant should indicate marital status and selective service classification. PO-132

SERVICE MANAGER wanted for nationally known tractor and implement line. Must know agriculture throughout United States and be capable of writing concise and instructive letters. An excellent future is assured the man that can qualify. PO-133

EXTENSION ENGINEER wanted. The Agricultural Extension Service, University of Nebraska, wishes to fill a position on its staff of agricultural engineering. A man with thorough engineering training and with experience in the fields of irrigation and erosion control, as well as in extension work, will be given preference. Qualified persons, who desire to apply, should send credentials to Agricultural Engineering Department, University of Nebraska, Lincoln, Nebraska.

POSITIONS WANTED

AGRICULTURAL IMPLEMENT BLOCKMAN, with eleven years' sales experience with large manufacturer of farm equipment and three years in agricultural engineering in engineering college, desires position as sales or collection blockman with another similar concern or would consider a position as teacher in farm shop, national defense, or farm machinery research work. Age 37, excellent health, no bad habits. Married. Rural background. Credentials furnished upon request. Am now teaching in state university but will be available September 1, 1941. Can revitalize, give new direction and effectiveness to sales or collection efforts through original methods. Proficient in management, organization, financing. Would prefer Middle West. PW-338

AGRICULTURAL ENGINEER, also farm and supply manager, has had 20 years' experience in agricultural pursuits as manager of large farming enterprise and agricultural supply house, and as chief agricultural engineer of large irrigation development in the West. Has had technical training and practical experience in all phases of engineering and agricultural production, development, and marketing. Best of references. Forty-four years of age. Married. PW-341